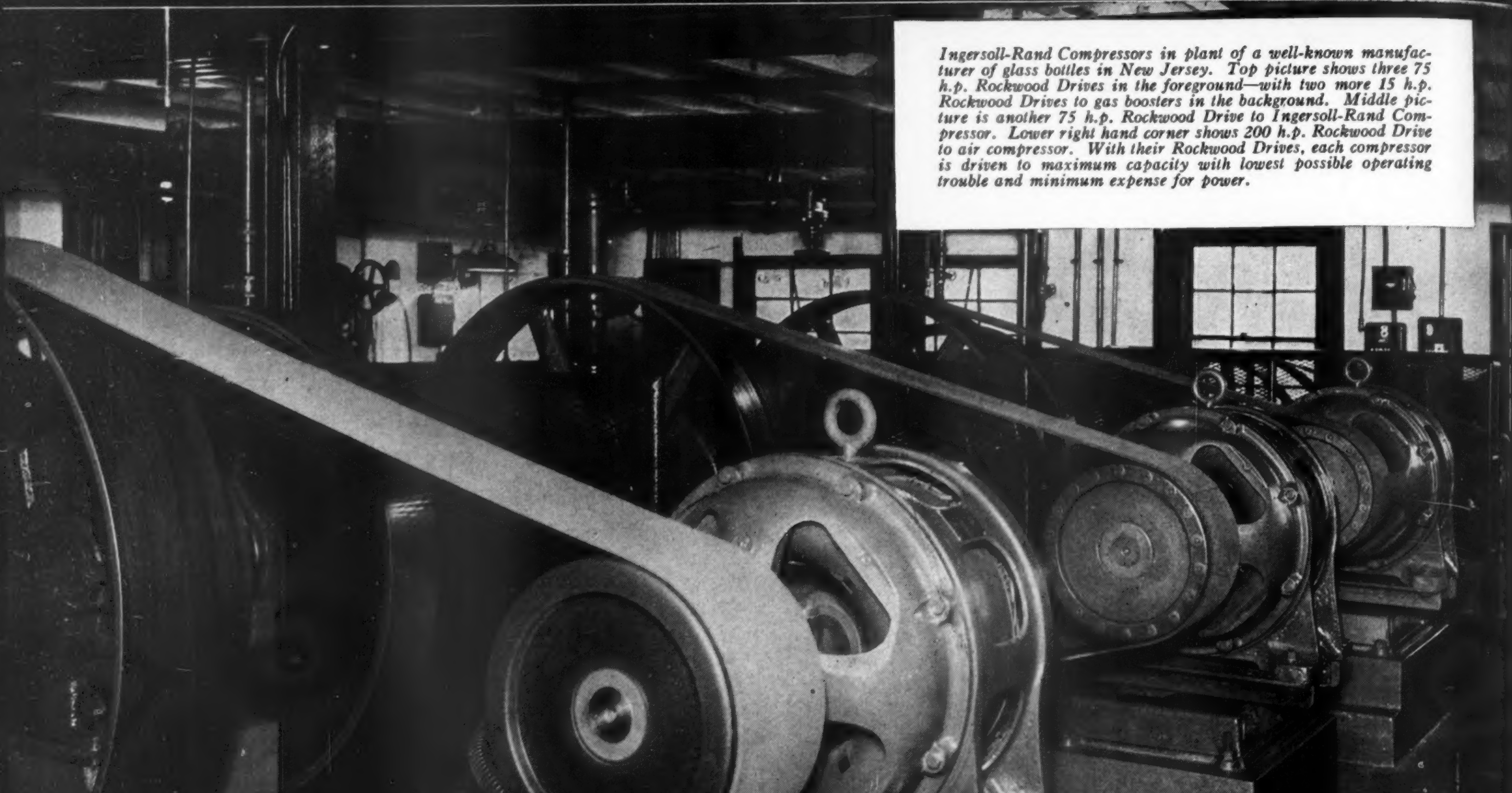
Compressed Air Magazine

VOLUME 46 · NUMBER 2 FEBRUARY 1941 LONDON · NEW YORK · PARIS

BOLIVIAN ORE TRAMMERS

MORE DEPENDABLE SERVICE FROM YOUR COMPRESSORS



Ingersoll-Rand Compressors in plant of a well-known manufacturer of glass bottles in New Jersey. Top picture shows three 75 h.p. Rockwood Drives in the foreground—with two more 15 h.p. Rockwood Drives to gas boosters in the background. Middle picture is another 75 h.p. Rockwood Drive to Ingersoll-Rand Compressor. Lower right hand corner shows 200 h.p. Rockwood Drive to air compressor. With their Rockwood Drives, each compressor is driven to maximum capacity with lowest possible operating trouble and minimum expense for power.

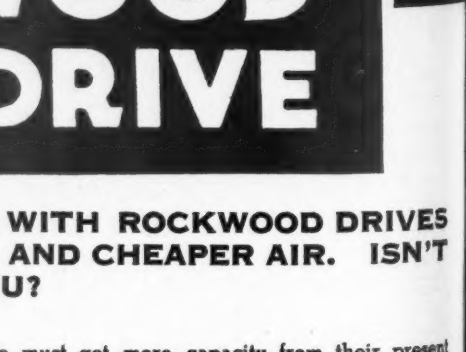
ROCKWOOD PIVOTED MOTOR DRIVE

COMPRESSORS EQUIPPED WITH ROCKWOOD DRIVES WILL GIVE YOU MORE AIR AND CHEAPER AIR. ISN'T THAT OF INTEREST TO YOU?

Belt driven compressors (either V belt or flat) invariably perform better with Rockwood pivoted-motor Drives than with any fixed center drive. That's because Rockwood Drives operate at higher power transmission efficiency and with less belt slip and speed drop than you get with fixed center drives.

When your compressor is equipped with a Rockwood Drive the pivoted motor mounting instantly and automatically adjusts itself for any and all variations in belt length. **MUCH MORE IMPORTANT, IT AUTOMATICALLY TIGHTENS OR SLACKENS ITS BELT WITH EACH AND EVERY CHANGE IN LOAD.** Thus, belt life is lengthened, maintenance is practically eliminated, power is saved, and maximum dependable compressor speeds wtih more air are the invariable result.

Plant engineers who must get more capacity from their present equipment—or maximum air from minimum power—send us your problems. For those interested in technical reasons for the Rockwood Drive, we have a pivoted-drive-data-book which we will be glad to send. Write today to the factory at Indianapolis—or ask your nearby Rockwood dealer.



Rockwood Manufacturing Company—*Indianapolis, Indiana*

ON THE COVER

OUR cover picture shows a group of native laborers in front of a masonry-walled ore bin at the Animas Mine of Cie. Aramayo de Mines en Bolivie. The mine is in southern Bolivia, at an altitude of approximately 15,000 feet, and produces tin. It will be noticed that all but two in the group are women. Their hats are typical of the styles of the country. The ore bin is about 30 feet high and was probably built by the Spaniards who worked the mine nearly three centuries ago.

IN THIS ISSUE

SOME persons read the financial pages of a newspaper understandingly: many others find the stock and bond tables of no interest, or even meaningless. To the latter group, the operations of the New York Stock Exchange are a mystery. Actually, however, there is nothing unfathomable about the procedure. It is simply a market place—one of the greatest in the world. It was set up and is run for the convenience of the public and of the corporations that must sell securities to raise money to carry on their business. Highly developed mechanical facilities enable the Exchange to function with almost incredible speed. Our leading article takes the reader behind the scenes.

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NEXT to gold, diamonds are a symbol of wealth to most of us, and hence of great interest. But, unlike gold, diamonds are of great practical value by virtue of their extreme hardness. The finest diamonds find use as gem stones, and probably always will. The less perfect ones are not aristocrats, but workers. New applications for them are being found daily in many industries. Whence come diamonds, and how are they mined and recovered? The answers are in an article starting on page 6357.

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UNCLE SAM is making a stupendous effort to create a merchant marine that can carry the bulk of our overseas commerce. Modern, well-designed and well-built ships that are speedy enough to compete successfully with the craft of other countries are coming off the ways in increasing numbers. These so-called C-2 Type vessels have many points of interest that are dealt with in an article entitled *Ships to Win and Hold Overseas Trade.*

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WHERE a mole travels underground, a ridge of earth appears on the surface. Chicago's subway burrowers, with their mechanical moles, threatened to push up the surface of State Street. To hold down utility vaults and basements of buildings many tons of ballast were placed, as told in an article starting on page 6368.

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ADVERTISING INDEX

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New York Stock Exchange

C. H. Vivian

18 BROAD STREET

Although the New York Stock Exchange owns an entire block, with numerous entrances, the actual trading takes place behind the pillars of stone shown here. The 8-story building was built in 1903, and is considered the masterpiece of the architect George B. Post. The great Corinthian columns resemble the porticos of ancient Roman temples. The pediment of the structure is embellished with a notable sculptured group by John Q.A. Ward. In the center is Integrity, flanked by figures symbolizing the industrial and agricultural pursuits of the nation. This picture was taken from the steps of the United States Subtreasury on Wall Street. In the right foreground is a well-known statue of George Washington.

IT IS estimated that approximately 15,000,000 persons in the United States own either stocks or bonds directly. Indirect owners include virtually all the 39,000,000 depositors in savings banks and the 63,000,000 holders of life-insurance policies, because every bank or insurance company of any consequence has some of its funds invested in securities. Established market places for the interchange of securities are essential. If they did not exist it would be so difficult to buy or sell stocks and bonds that few people would care to invest money in them. It would be impossible to keep informed of their value from day to day, and banks would be reluctant to accept them as collateral for loans. In short, they would lack the liquidity they now possess and by reason of which they can be converted into cash at any time.

The first important market place of this kind was in London, where brokers gathered daily in coffee houses to trade in interest-bearing securities. Those who were accustomed to meet in Jonathan's Coffee House formed an association in 1773 for the exchange of stocks and bonds. They gave it the name of the Stock Exchange, and the building in which they transacted business was called The Stock Exchange Coffee House. In 1801 a group of these brokers raised $100,000 to purchase lots and to erect a building in Capel Court, Bartholomew Lane. It was opened in 1802 with 500 members, and forms one of the entrances to the present London Stock Exchange.

Foremost among the securities exchanges in the United States is the New York Stock Exchange. It has evolved from an outdoor market at what is now 68 Wall Street, where a few bewigged brokers met each day beneath a buttonwood tree to do their trading. On May 17, 1792, twenty-four of them drew up an agreement prescribing methods of doing business. At that time the principal trading was in stock of the United States Bank and in an $80,000,000 Government bond issue that had been brought out to refund the Revolutionary War debt. In 1817, when about 30 stocks were handled, the group moved indoors, to a rented second-story room at 40 Wall Street. Just prior to the move, the organization adopted a constitution and took the name of New York Stock and Exchange Board. This was changed to the present title in 1863, in which year land was acquired for a building that was erected at 13 Wall Street and occupied in 1865. The location is a part of the site of the existing Exchange which, through new construction and the acquisition of buildings, has come to own the entire block in lower Manhattan bounded by Wall, Broad, and New streets and Exchange Place. An 8-story unit that contains the "trading floor" was put up in 1903, and a new 23-story structure fronting on Wall Street was built in 1922. A cofferdam extending to bedrock, in some places 70 feet deep, surrounds the foundation of the latter and is waterproofed to withstand a hydrostatic pressure of 40 pounds per square inch.

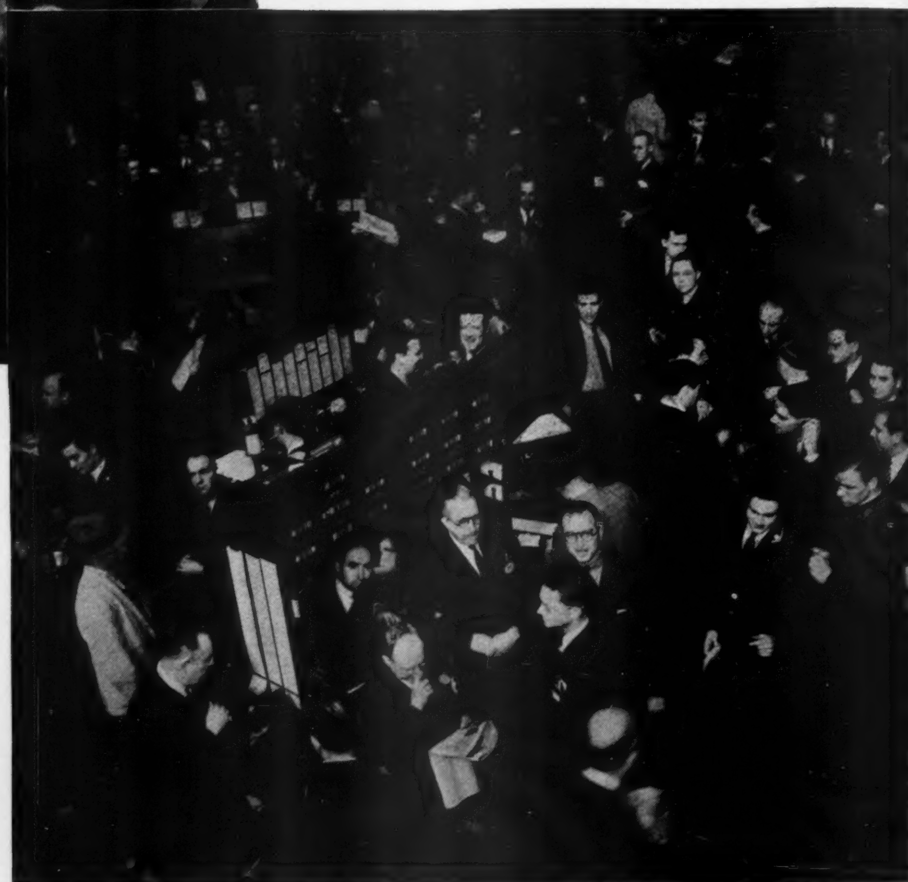
During the greater part of the past century the bulk of the trading on the Exchange was in Government securities and in those of railroad companies that played a vital part in the colonization of the West. With the opening of the Pennsylvania petroleum fields, oil-company shares became prominent, and then the shares of metal-mining concerns in the West made their appearance. The introduction of gas, electricity, and the telephone resulted in numerous public-utility-company securities. Finally, beginning about 50 years ago, large industrial and manufacturing concerns began to enter the economic scene, and their stocks and bonds now reach a greater monetary total than those of any other group.

Known in financial parlance as the "Big Board," the New York Stock Exchange far outstrips all others in the nation in volume of business transacted and vies with the London Exchange for world supremacy. The London market does not publish sufficient figures to make a fair comparison possible. So far as the securities business in this country is concerned, the dominance of the New York Stock Exchange is told by statistics. In 1939, the dollar volume of stock transactions in the United States was $11,420,996,520, of which the New York Stock Exchange accounted for $9,968,173,205. Total bond transactions amounted to $1,921,096,111, with sales through the Exchange aggregating $1,517,956,894.

Before a security can be listed for trading on the Exchange, the issuer must submit a comprehensive and detailed report

THE TRADING FLOOR

Behind the portals of the building shown on the preceding page is this vast room that measures 140x115 feet and is 79 feet high. At the time it was constructed it was the largest enclosure in New York. Its flat roof is supported on steel trusses that weigh up to 137 tons each. It was one of the first spaces in New York to be air conditioned. The original equipment, set up in 1903, included an ammonia absorption system of 450 tons. In 1922 the absorption system was replaced by four ammonia compressors with an aggregate capacity of 750 tons, and air conditioning was extended to sections of the new building that was constructed that year. The picture was taken from the visitors' gallery and shows a part of the throng of 3,000 persons that is normally there during trading hours. A number of the horseshoe-shaped trading posts—some of them double ones—are visible, and along the far wall are some of the stalls in which private telephone wires from member firms terminate. On the left wall is one of the huge annunciator boards where brokers' numbers are flashed when their telephone clerks desire to summon them to receive orders from customers.



THE HEART OF THE MART

The milling crowds—made up of brokers, clerks, page boys, reporters, and "quote" boys—around some of the posts. Below is seen Post No. 1. Around its outside may be seen lettered panels designating the stations where trading in different stocks is going on. The price of the latest sale is always on display for the information of brokers arriving with buying or selling orders. Near the right edge, with a hand on the receiver of his headphone, is a quotation clerk who supplies the quotation department in another part of the building with the current bid and asked prices of stocks traded in at that post. The other picture shows the interior of Post No. 5. In the center is a pneumatic-tube station. As these pictures reveal, the term "Stock Exchange seat" is an archaic expression that dates from the time when members sat and bid on each stock in turn as it was called up for trading.

concerning its earnings, its management, the nature and extent of its business, and other pertinent data, and it must agree to furnish regular certified financial statements containing adequate and accurate information regarding its financial condition and its operations. The concern must have an established business of a designated minimum size, and the volume and distribution of its securities must be sufficient to warrant a national market for them. A thorough investigation of all matters pertaining to the applicant's methods of doing business is conducted by the Exchange's committee on stock list, and only those firms that conform to the standards set are permitted to list securities for trading. The Exchange does not pass judgment on the value of the securities; but it does say in effect that it considers them proper for public trading. It also endeavors to protect the investing public by requiring all concerns whose stocks are listed to make available the most complete and accurate information possible on their financial status.

As of January 1, 1941, there were listed on the Exchange 1,230 stock issues of 862 companies. The total number of shares was 1,454,761,737, and their market value was $41,890,646,959. There were 1,295 bond issues, representing 606 issuers, and their market value was $50,831,283,315, giving an aggregate value for both stocks and bonds of $92,721,930,274.

There are many misconceptions regarding the nature and functions of the Exchange. It is in reality very much like a tobacco auction market, where buyers openly bid against one another. The New York Stock Exchange is composed of 1,375 members, each of whom bought his membership and pays $1,000 a year in dues. Other income of the Exchange is derived principally from fees for listing new securities, for the services of the Stock Clearing Corporation maintained by it, and for the dissemination of reports of securities transactions by means of the ticker service, as well as from rents from tenants in its buildings.

As an organization, the Exchange does not buy or sell securities, has no part in fixing prices, and receives none of the proceeds of a transaction or of the commissions charged by members. Its function is to provide a market place and to maintain, through its governing action, certain standards of business conduct among its members. The board of governors consists of 32 members, three of whom are representatives of the public. The only salaried officer on the board is the president, and he was not put on that basis until 1938. Trading on the floor is open to public view, and in 1940 approximately 150,000 visitors were taken to the gallery and then to an exhibition room where the workings of the Exchange were explained to them by a staff of receptionists.

The machinery of the Exchange has been developed to a point where it functions smoothly and with incredible speed and precision. To illustrate this, let us assume that John Smith in San Francisco decides to buy 100 shares of United States Steel Corporation common stock. He visits or telephones a local brokerage office of a member firm of the New York Stock Exchange and learns that the last sale reported by the ticker was at $70 a share. But as that sale may have taken place a few minutes previously, he asks for a quotation. A clerk calls the firm's New York office by private wire and requests a "quote on Steel." Another clerk at the New York end calls, over a private telephone, the quotation department of the Exchange and immediately obtains and

relays to San Francisco the current "bid" and "asked" prices of the stock. Ordinarily, Mr. Smith will have the information within a minute after he inquires.

Now suppose that Mr. Smith was told that "Steel" is $69\frac{3}{4}$-70. That means that someone stands ready to pay $69.75 a share and that someone else is offering it at $70 a share. If Mr. Smith is willing to pay $70, he instructs a clerk to buy 100 shares for him "at the market." This order is telephoned to the New York office, which transmits it to the Exchange in like manner. Under average conditions, it will be only a matter of from three to ten minutes until Mr. Smith is notified that he has bought the 100 shares of stock. Even before he receives the report on his purchase, the stock ticker in the San Francisco brokerage office may have printed the transaction.

In order to learn how all this is done in so short a time, let us delve a little deeper into the human and mechanical facilities that actuate stock and bond dealings. The main trading floor of the Exchange is a huge room, 140x115 feet and 79 feet high. Arranged around it are horseshoe-shaped trading posts. There are eighteen of these, some located in an adjoining but connected space because the builders of the room did not foresee the extent to which the operations would develop. Approximately 60 stocks are traded in at each post, and to each stock is allotted a location outside of the horseshoe. The bond-trading department is in an annex to the main floor and is referred to as "the bond crowd." The equipment employed there and the procedure followed are essentially the same as those used for stocks.

On an average day there are close to 3,000 persons on the floor. Actual trading can be conducted only by members of the Exchange, most of whom are affiliated with some 600 "member brokerage firms" about three-fourths of which have their head offices in New York. These member firms have approximately 3,300 partners and maintain nearly 1,000 branch offices in this country and abroad. In addition, they have private-wire connections with some 3,000 non-member correspondents. As the Exchange has 1,375 members, and there are only about 600 member firms, it is apparent that many brokerage houses have more than one representative on the floor. Normally, around 1,000 brokers are present. Every brokerage house has at least one private telephone wire to the floor, and many of them have more. For each telephone there is a clerk, and these clerks, together with pages, reporters, pneumatic-tube operators, and others, make up the remainder of the throng of 3,000.

The volume of business on the Exchange is not so heavy as it was a few years ago. In fact, the 1940 total of 207,599,749 shares handled was the smallest since 1921. However, there often is great variation from day to day or from week to week. For example, on May 21, last, the turnover was 3,939,610 shares, while on August 19 it was only 129,650 shares. The trend cannot be forecast, because economic or war news can and does frequently increase or reduce the volume enormously overnight. Consequently, the mechanical and human facilities of the Exchange must be on a scale that can take care of any amount of business that may arise.

Now let us accompany Mr. Smith's order to the floor of the Exchange. A telephone clerk employed by the New York firm through which it was placed jots it down when he receives it over the private wire. To get in touch with the floor member of the brokerage house who will execute the order, he presses a button that flaps the member's number on huge electrically operated annunciator boards high on the walls of the room. Seeing his number "up," the broker goes immediately to his firm's telephone booth and receives the order from the clerk. Then he goes to Post No. 2, which is the designated trading place for U.S. Steel stock. A group of brokers with buying or selling orders for the same stock is already there, and he asks: "How's Steel?"

As several minutes have elapsed since Mr. Smith obtained his quotation of $69\frac{3}{4}$-70, the price has changed and he is informed that $69\frac{7}{8}$ is now bid for it and

QUOTATION DEPARTMENT

Two hundred and forty-four private telephones from member firms' offices terminate in this room, where 77 girls are on duty to give out bid and asked quotations on all stocks. Quotation clerks on the trading floor telephone all price changes to this department. The girls at the sides of the room receive the calls and, by depressing keys of instruments before them, change the figures on the paneled boards on the walls. Each girl has a certain group of stocks to watch and needs to look only at the panel opposite her to note the current quotations. The inquirer in the brokerage office gets the right girl by dialing a number assigned to the stock on which he wants a quotation. Time clocks control red lights at each stock-indicating point on the panels, and these are illuminated automatically if no price change has been received on the stock concerned for seventeen minutes. The panel operator then calls the quotation clerk assigned to that stock on the floor and checks the prices displayed.

A TUBE STATION AND BLOWERS

Figures on the average number of messages transmitted daily by pneumatic tubes within the Exchange are not obtainable, but estimates place the total at around 50,000. Pictured here is a station that serves a group of telephones manned by clerks of member brokerage firms. The operator is inserting in a tube one of the small wooden carriers of which one end is open. They are made of maple and are bought in lots of 50,000. In the slang of the Exchange, they are known by the meaningless name of "widget"; and one of the minor annoyances to the management is the "great widget mystery." Starting about two years ago, the carriers began to disappear in rather large quantities, and, although every clue has been investigated, they continue to vanish at the rate of from 500 to 800 weekly. No one can fathom the riddle. As they cost but two cents each, the monetary loss is not great, but it would have been serious a few years ago when carriers of another material were employed at a cost of 28 cents each. The other picture shows two of the six motor-driven blowers that supply operating air for this tube system. Four were installed originally and two were added later. Each unit has a capacity of 7,500 cfm. of air at $1\frac{1}{2}$ pounds pressure.

$70\frac{1}{8}$ asked. As he is authorized to buy at the market he could pay the asking price, but he endeavors to save his client money and bids 70 for 100 shares, which is higher than any other current bid. Another broker who has an order to sell 100 shares at the market and who has been asking $70\frac{1}{8}$ also has his client's interest in mind. As this is a better offer than any previously made he decides to take it and calls out, "Sold." By this verbal agreement the transaction is negotiated: no papers are exchanged, no signatures are obtained. Each broker simply makes a penciled note of the transaction. If he does not know the man with whom he has dealt he obtains his name and firm connection from the badge that all members wear while on the floor.

Mr. Smith's broker concludes his part of the business by handing a memorandum of the purchase to his telephone clerk who, in turn, reports it to the firm's office. The office informs its San Francisco branch; and Mr. Smith is notified. The actual delivery of the stock and payment for it are made on the second full business day following. If Mr. Smith pays the full amount of \$7,000, plus the broker's commission of \$20, he receives within a few days a certificate made out to him and registered in his name on the books of the company or of its stock-transfer agent. If he desires to pay only part of the total, he can do so.

Under the regulations of the Securities Exchange Commission, an agency of the Federal Government, at least 40 per cent of the sum due must be paid. This payment is known as "margin," and the transaction is called "buying on margin." In a case of this kind the broker advances the remaining 60 per cent as a loan, and the stock certificate is made out in the name of the brokerage house which holds it as collateral for the loan. The firm may, in turn, hypothecate the certificate to a bank. The total amount thus borrowed by its members is reported by the Exchange at regular intervals and is published in the newspapers as "brokers' borrowings." Mr. Smith is charged interest monthly on his unpaid balance; but he is credited with any dividends that may be declared on the stock. Margin buying, which is misunderstood by a large percentage of the public, is similar to the practice regularly followed in buying real estate. There the purchaser pays a certain sum of money, borrows the remainder, and gives a trust deed or mortgage on the property to secure the loan.

Now let us return to the trading floor. Standing in the group where the sale was made was an Exchange reporter who made a note of it on a small pad. All he wrote was "X 70." The "X" is the symbol for U.S. Steel and the "70" was, of course, the price. The trading unit of most stocks is 100 shares, and as no number was stated we know that the transaction covered 100 shares. The reporter tore the page off his pad and handed the slip to a pneumatic-tube attendant. The latter placed it in a carrier which he inserted in a tube, where a rush of air swished it to the ticker transmitting room on the fifth floor of the building. In that room are three operators' tables, each of which is served by six pneumatic tubes, and each tube brings sales report slips from one of the eighteen stock trading posts on the floor.

In a market of normal activity four girls are stationed at each table. Two remove the slips from the tube carriers, the third operates a tape-perforating machine, and the fourth checks the sales slips against

the printed reports on a ticker. In a busy market, three or more girls are needed to attend to the carriers. All the girls are trained to work at any of the stations; and they change positions every half hour to lessen fatigue. Upon its removal from a carrier, the first girl places the slip on a horizontal moving belt that takes it past the perforating station. The girl seated there reads it and records the information in code—a combination of holes (a maximum of six) in an oil-impregnated paper strip ⅞ inch wide. The perforating machine resembles a typewriter, and the tape automatically moves through it 1/10 inch after each character is perforated.

A record of all the trading is thus made on three separate tapes, the work being distributed because one crew could not keep abreast of sales in even a reasonably busy market. The average operator can perforate tape at a rate of 265 characters a minute, whereas the new high-speed ticker adopted in 1930 can print 500 characters a minute. It is therefore necessary to transfer the information from all three tapes to a single ticker tape and to convert the code to conventional symbols and figures. To do this, each perforated tape is fed into a separate transmitting unit, which is a small magnetically operated device. The tape moves forward one character at a time and stops for an instant at each one. During each stop interval, six metal fingers—each of which controls a contact in an electrical relay circuit—attempt to pass through the tape from below. Wherever there is a hole, the finger moves through it far enough to close the contact: where there is no hole, the finger is stopped and the contact which controls that relay is not closed.

In this manner, the combination of perforations is transformed into a combination of electrical impulses, and this is done at the rate of 700 characters a minute. These impulses control the operation of a reperforator in another part of the building. As the reperforator can reproduce only one tape at a time, a transfer circuit is arranged to take the three in succession from the perforating stations. The transfer from one tape to another takes place where there is a blank space in each tape, and such a space is ordinarily left by the operator after a sale is recorded. Reports from all sections of the floor are thus sent out with equal promptness. If, however, the activity on the floor is such that one station is busier than the two others, the reperforator can be made to take two or more reports instead of just one from that station's tape each time its turn comes. This can be done in either of two ways. The perforating-machine operator can omit the customary blank space between quotations, or the transfer circuit can be prevented from disconnecting the overloaded tape from the reperforator until normal conditions are restored.

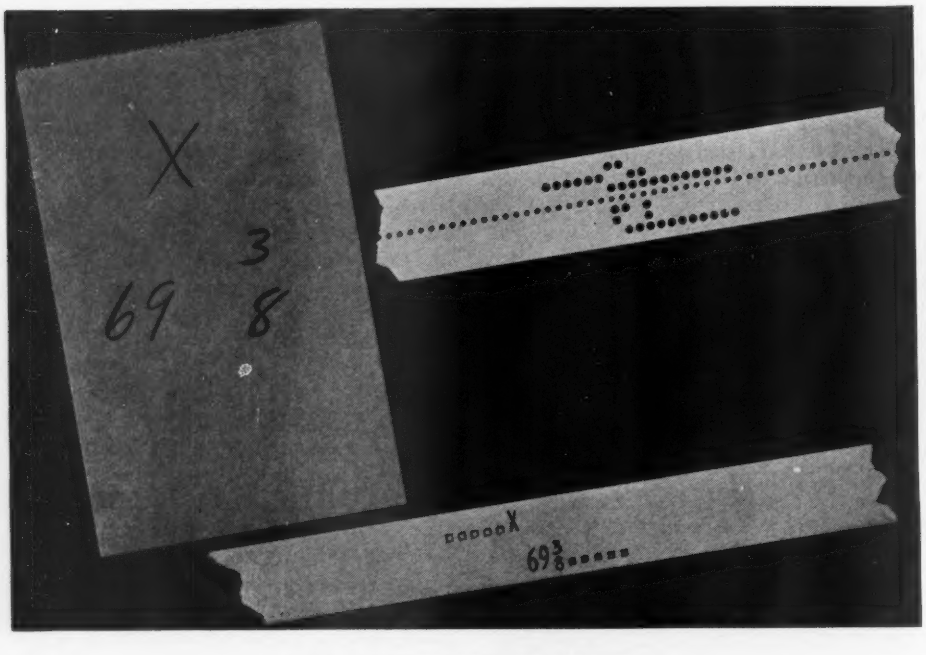
On the tape issuing from the reperforator is a code record of all the transactions. The final step of transferring this to the ticker is accomplished by feeding the tape into a master transmitter that functions the same as the transmitter at the operators' tables and moves the tape at the rate of 500 characters a minute. However, up to this point the combinations of impulses have been handled simultaneously by means of six circuits. If this were continued throughout the system it would be necessary to carry six circuits to each ticker, and the cost would be prohibitive in view of the large number of tickers and their wide distribution. Accordingly, the master transmitter—a rotary unit—and its associate vacuum-tube repeater are arranged so as to convert the impulses delivered by the six circuits into a series of positive and negative impulses that can be sent over one wire.

Space does not permit a detailed description of this equipment nor of the manner in which these impulses operate the ticker. Suffice it to state that eight electrical impulses (positive and negative) are required to transmit each character, and that they are sent out over one wire. Two of them, called start and stop impulses, control the motion of the ticker selector and type shafts, five control the motion of five code disks; and the eighth distinguishes between letters and figures. Actual printing is done with a type wheel on which is molded a rubber strip containing 64 characters and which is turned to the proper character each time the tape is advanced a step. The figures are placed beneath the letters on the typewheel and print on the lower half of the tape, whereas the stock symbols print on the upper half. The New York Quotation Company, a subsidiary of the Exchange, operates about 800 tickers in member firms' offices in lower Manhattan, while approximately 1,820 additional units elsewhere in New York and throughout the country are operated by the Western Union Telegraph Company.

At each of the three operators' tables in the ticker transmitting room there is a stock ticker. A girl sits in front of it and compares the printed display with the original sales slips from which the record

TICKER TRANSMISSION STATION

This is one of three similar lines that jointly perform the manual operations involved in sending out reports of stock transactions over the ticker system. The girl at the right removes sales slips from pneumatic tube carriers as they arrive from six of the eighteen trading posts. She places these slips upright on a moving belt. As they pass in front of the second girl, she operates a machine that resembles a typewriter and that perforates a paper tape in code. This tape passes through a transmitter that converts the code into electrical impulses. These impulses, together with those from the two other lines, actuate a reperforator located in another part of the building. The reperforator takes one sale in turn from each station and the reperforated tape is run through a rotary transmitter, or distributor, where the perforations set up electrical impulses that go out over the wires to the tickers, some of which are 3,000 miles away. The third girl, on the left, compares the original sales slips with the figures on the ticker tape to guard against errors.



FROM SALES SLIP TO TICKER

At the left is an original report from the trading floor on a sale of 100 shares of U.S. Steel stock. At the right, top, is a section of perforated tape showing the same characters in code. Below it is a piece of ticker tape bearing the printed report of the transaction. Tickers were introduced in 1867 and have undergone continual improvement. The model used since 1930 prints 500 characters a minute, as compared with 250 by its predecessor. On January 1, 1940, there were 2,585 stock tickers and 402 bond tickers in operation in 328 cities in 44 states, the District of Columbia, Canada, and Cuba. New York led with 1,350, and Pennsylvania was second with 214. Ticker tape is a strip of paper ¾-inch wide. In recording the transactions of the New York Stock Exchange on a 3,000,000-share day, each ticker consumes about 1,500 feet of tape. As much as 80,000,000 feet or 15,000 miles of tape has been used in a single day by the stock tickers alone.

was made. Actually, all the steps that have been described take place in a fraction of the time required to read about them. In an average market, there is an interval of perhaps only fifteen seconds between the time a sales slip is removed from a tube carrier and it appears on the ticker. In a very busy market, the slips accumulate faster than they can be handled, and the ticker falls behind until a lull enables it to catch up. Under such circumstances, approximately every tenth one arriving from the trading floor is stamped with the time it was received. When the sales slip is compared with its counterpart on the tape, the time is again noted. This is done at all three transmitting stations, and the time differences are averaged to determine the approximate lateness of the tape. This information is furnished periodically to the offices of ticker-service subscribers, where it is displayed on a special indicator.

Stock and bond sales were reported on a single ticker until 1919, when a separate bond ticker system was established. There are four trading posts on the bond floor, and three pneumatic tubes extend from them to the bond-ticker transmitting station, which is in the room with the stock transmission facilities. Also in the same room are volume-printer transmitting stations that send hourly reports on the volume of each stock traded in to the offices of the newspapers and news-gathering agencies in New York. These figures are used in making up the stock tables in newspapers.

The pneumatic-tube system of the Exchange is worthy of special mention. More than 30 miles of brass tubing is installed, most of it in a 30-inch vertical space between the trading floor and the ceiling of the offices on the floor below. These tubes have an inside diameter of 1¼ inches. The members' private telephone wires to the trading floor number 1,575, and their terminals are ranged along the three walls of square enclosures open to and extending around the trading floor. The tube system and most of the telephone booths were put in in 1922, and tubes were run from each trading post to each booth.

Additional telephones were installed in 1929 to accommodate the 275 new members admitted to the Exchange at that time. To give them tube service, there were set up twelve relay stations—ten in the stock and two in the bond-trading area—each of which is connected with a station served by tubes leading to every trading post. There is also a transfer station with tube connections to all telephones and all trading posts. This provides an alternate system for use in case the regular facilities are overloaded or out of commission for any reason. Furthermore, tubes extend from a central point on the trading floor to each of the six entrances to the building for the purpose of transmitting messages to and from brokers on the floor. We have already mentioned the 21 tubes that link the trading floor with the stock and bond ticker department.

The carriers used in this 1¼-inch tube system are wooden cylinders about 3 inches long and having a strip of felt wrapped around each end to serve as silencers and to reduce air leakage. The system operates under a pressure of 30 inches of water, or about 1.1 pounds of air. This is supplied by six General Electric Type T blowers which, in their modern form, are the FS Type and are manufactured by Ingersoll-Rand Company. Each blower has a capacity of 7,500 cfm. at 1½ pounds pressure and is driven at 3,550 rpm. by a 90-hp., 230-volt, direct-current motor.

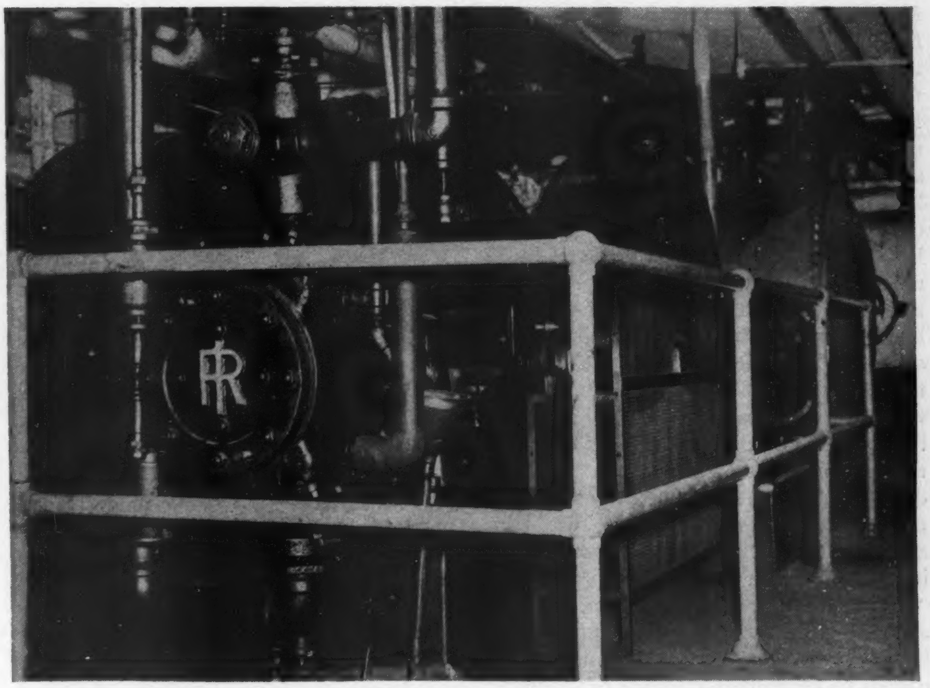
Besides the tube system described there is one in the offices of the Stock Clearing Corporation that moves securities from one department to another and serves in lieu of messengers. The tubes are of oval cross section, measuring 4x7 inches, and are supplied with air from a separate blower. Until recently there was also a 7x15-inch tube system that ran from the Department of Central Records on the fifteenth floor of one of the buildings to offices on the eleventh and sixth floors, respectively, in two other buildings. This is no longer required because the offices have been relocated. In addition to the low-pressure air for the tubes, the Exchange uses air at 50 pounds pressure for ejecting sewage and for clearing the pneumatic tubes whenever stoppages occur. This air is furnished by two Ingersoll-

TELEPHONE CLERKS

The first telephone was placed in the Exchange on November 13, 1878. Now 1,321 private telephone wires of members terminate on the trading floor. They are manned by clerks who receive orders from their firms and transmit reports of their execution. All told, nearly 1,200 telephone clerks are employed on the floor.

Rand Class ER 12x10-inch single-stage compressors each belt driven by a 50-hp. motor.

Another interesting feature of the Exchange that renders speedy service to the public is the quotation department from which the bid and asked prices for any listed stock can be obtained immediately. This was inaugurated on an experimental basis in September 1928 to give prices on a few stocks, and was so successful that it was expanded in the following month to include all stocks. It operates with the help of 99 boys, who gather the quotations on the trading floor, and 77 girls, who give them out by telephone to inquirers. There are 244 direct wires from brokerage offices that terminate in the quotation room. These are dial phones, and each number in the directory represents a stock. For example, if you want a quotation on U.S. Steel from a brokerage office, a clerk dials 29 and asks, "How is Steel?" The girl who answers has only to look up at an electrically operated board on the wall facing her to obtain the current bid and asked prices. Every time there is a change in either on the trading floor, a boy, wearing a transmitter chest telephone, relays it to the quotation room, where a girl operates an instrument that changes the figures on the board. As many as 173,793 quotations have been given out in one day. (The Exchange is open from 10 to 3, excepting Saturdays, when the doors close at noon.)



AIR COMPRESSORS

One of two duplicate units that furnish compressed air at 50 pounds pressure. The principal use of this air is for ejecting sewage, the basements of some of the group of buildings being as much as 35 feet below the sewers in the adjacent streets. Air lines extend to points near all pneumatic-tube stations, and reels of hose are attached to their outlets. Whenever there is a stoppage in a tube, this higher-pressure air serves to clear it. If the air will not do this unaided, a steel ball is placed in the tube and, with the 50-pound air force behind it, becomes a projectile that produces the desired result. Some of the air from these machines is reduced to 15 pounds pressure and used for operating controlling thermostatic instruments on heating and air-conditioning systems.

In 1937, the calls answered numbered 25,464,829, the daily average being 85,674. In the first half-hour of trading on October 28, 1937, a total of 25,872 quotations were given out. While on the subject of telephones, it should be mentioned that approximately 1,900 private wires from members' offices run into the Exchange and that nearly 1,400 telephone clerks are employed. At times nearly 2,000,000 calls are transmitted over these wires in a 5-hour day, an average of more than three a minute on each telephone. In the Exchange are 70,000 miles of telephone and telegraph wires.

To return to our Mr. Smith in San Francisco, let us suppose that he buys only seventeen shares of U.S. Steel stock. This is termed an odd lot, because the unit of trading for that stock is 100 shares. In a case of this kind the regular commission broker on the floor does not execute the order. Instead, the telephone clerk receiving the order sends it by pneumatic tube to Post 15, addressing it to a representative of a firm making a business of dealing in odd lots of securities traded in at that post. There are approximately 130 members of the Exchange that specialize in this business. Assuming that the next sale of the stock is at 70, the odd-lot broker reports to Mr. Smith's broker that he has sold him seventeen shares at 70⅛. The differential of ⅛ point, or 12½ cents a share, is the former's commission. Odd-lot brokers buy their stock in 100-share lots. While 100-share-lot trading is the general rule, stocks in which activity lags are frequently exchanged in 10-share lots. These are assigned to a special post, No. 30, and are not to be confused with odd lots.

Let us suppose, again, that Mr. Smith was not willing to pay the $70 a share asked for the stock, but believed that by waiting a few days he could get it for $65 a share. This time the broker representing him marks the limited (as to price) order G.T.C. (good till canceled) and delivers it in person or by pneumatic tube to a broker, known as a specialist, at Post 2. There are one or more specialists in every active stock—approximately 320 in all. They are both dealers and brokers; but they cannot serve in both capacities in the same transaction.

The specialist is a broker for brokers and receives a fixed commission for his service. He enters Mr. Smith's order in his book, and if and when the stock declines to 65 he sends Mr. Smith's broker a memorandum that the stock has been bought. A limited order, or one that is "away from the market," may be used in other ways. For instance, should Mr. Smith, after acquiring his stock at 65, decide to dispose of it if and when it reaches 75, he can, instead of waiting, place a G.T.C. order with his broker to sell at 75. The latter will list it with a specialist, and the transaction will be made when the stock advances to that figure. Again, Mr. Smith may wish to protect himself against too great a possible loss, say not more than $5 a share. He can do this by placing a G.T.C. order to sell at 60. When business gets so active that Mr. Smith's broker cannot with dispatch handle all the orders sent to him on the floor, he calls to his assistance a so-called "$2 broker," a name that persists because in former days his fee for each 100 shares he bought or sold was $2. Today his fee is graduated according to the price of the security. The $2 broker frequently acts also for another broker when the latter goes to lunch or leaves the floor for any reason.

The Exchange has developed a system that greatly expedites the procedure of delivering and settling for securities bought and sold among the various brokerage houses. A subsidiary, the Stock Clearing Corporation, serves as a central place for these transfers. Members turn over to it the securities they have sold, and receive credit for the purchase price on its books. They also take possession of any securities they have bought and are debited on the books with the amounts they owe. At the end of the day settlement is made, each member paying to the Stock Clearing Corporation the amount he owes or receiving from it any balance due him.

The Night Clearing Branch of the Stock Clearing Corporation, so named because it

formerly met at night, still further simplifies the transfer of securities. It may be that Broker "A" has bought a security from Broker "B" and sold it the same day to Broker "C." Intermediate deliveries and money payments are eliminated by sending the security direct to Broker "C," letting the three brokers settle the financial end among themselves. The night branch, which now works in the morning, receives from each member a report of the number of 100-share lots of stocks he has bought and sold during the previous day's trading, including in each instance the price and the name of the member with whom he traded. By comparing the lists, the Night Branch is able to instruct the various brokers to whom to make deliveries. These, as previously mentioned, and settlement of the accounts, are then made through the Stock Clearing Corporation.

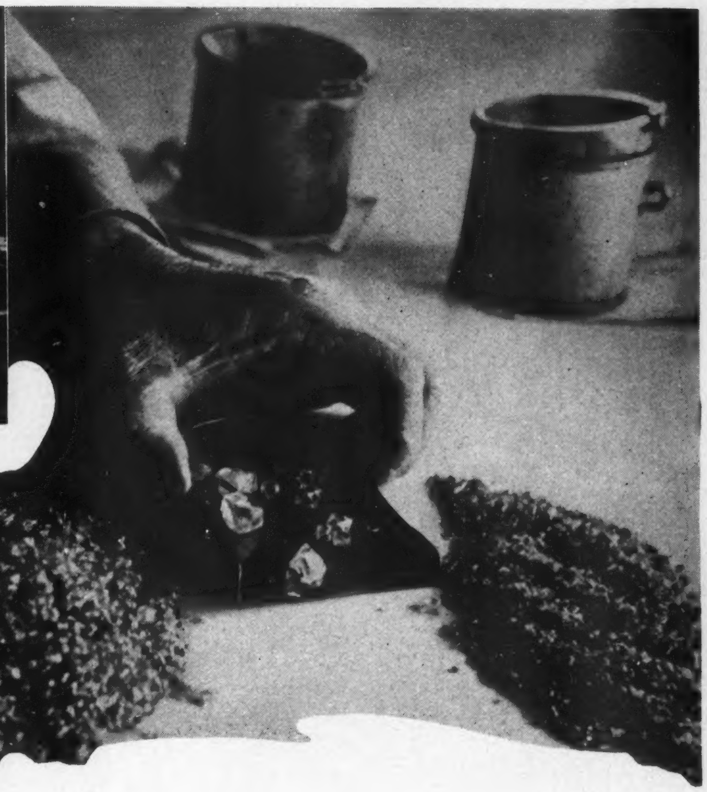
From what has been written, and the account is necessarily incomplete, it will be apparent that a large personnel is required to keep the Exchange functioning. As of January 1, 1941, it had 1,674 active employees and 125 on the retired list. The floor-operations staff alone numbered 757 persons, including 172 pages and 107 pneumatic-tube attendants. The Stock Clearing Corporation force totaled 261 persons, and the New York Stock Exchange Building Company, a subsidiary that operates and maintains the solid block of buildings, had 290 employees.

In almost all brokerage stock offices there is a board (hence the name board room) on which current prices of a broad selected group of listed stocks are displayed for the information of customers. It usually shows the closing price of each security on the previous day and the current day's opening, high, low, and latest prices. Formerly, boys marked them on the board with chalk, obtaining the figures from the stock ticker. Later, many of the houses utilized numerals printed on pieces of cardboard sized so as to fit snugly between retaining wooden strips running across the board. In 1929 was introduced an electrically operated board that was developed by Robert L. Daine, a French engineer. It is known as the Teleregister, and the Teleregister Corporation is an affiliate of the Western Union Telegraph Company.

Boards of the electric type have been placed on a monthly rental basis in 220 offices, 170 of which are in New York. Prices obtained from a ticker are transmitted from a room at 480 Canal Street, New York, over leased wires. Six sending tables are provided, with an editor, operator, and checker at each one so as to keep abreast of the ticker even on the busiest days. In each subscriber's office the electrical impulses are received in a cabinet containing an electric mechanism that selects the quotations for only those stocks that are displayed on the associate board. The figures are mounted on cylindrical indicator units which are automatically turned so that the correct digits and fractions appear in the appropriate openings on the board. Unit prices are shown in white and fractions in orange. The boards are made up in panels each containing sufficient space for posting the prices of ten stocks. The largest one is in Buffalo and can display 800 stocks.

TELEREGISTER QUOTATION BOARD

In many stock-brokerage offices, customers are kept informed on the prices of securities and commodities by electrically operated boards leased and serviced by the Teleregister Corporation. Stock prices taken from tickers are transmitted over Western Union leased wires from a central sending station in New York. The smaller picture shows a section of such a board. The figures are 1 inch high and are on cylinders that are revolved until the correct ones appear in the apertures in the board. For most stocks the standard minimum advance or decline is 1/8 point, or 12½ cents a share. Whole numbers are indicated on the board in white, and eighths in orange. For example, the day's high for the stock whose symbol is "EK" was 241 6/8, or $241.75. The first figure in this price, a "2," is displayed only at the top of the column, thus making a saving in the number of cylinders required. For the stock just referred to are needed sixteen cylinders. As two wires run from the controlling mechanism in the brokerage office to each indicator, 32 wires are required to make price changes in this one stock.



FINISHING OPERATIONS

The rough diamonds (right), some of which are nearly perfect octahedral crystals, are placed in small cans for convenient handling, and are then graded. Using a small scoop, an expert sorts the stones into several piles according to size and grade. Many diamonds are sold to brokers while in a rough state and, to determine their value, they are graded by experts for both buyer and seller. After the various piles are formed, an appraiser quickly counts and examines the individual stones in each one and sets down his estimate of their value on a piece of paper. He then gathers them all together, puts them in a can and passes them along to another expert, who repeats the process. It is said that there will be little variation in the totals arrived at by the various examiners. The cutting of diamonds into gems is a highly developed art that is now largely centered in the United States. A group of workmen polishing cut stones is shown above.

The Power of Diamonds

C. F. Greeves-Carpenter

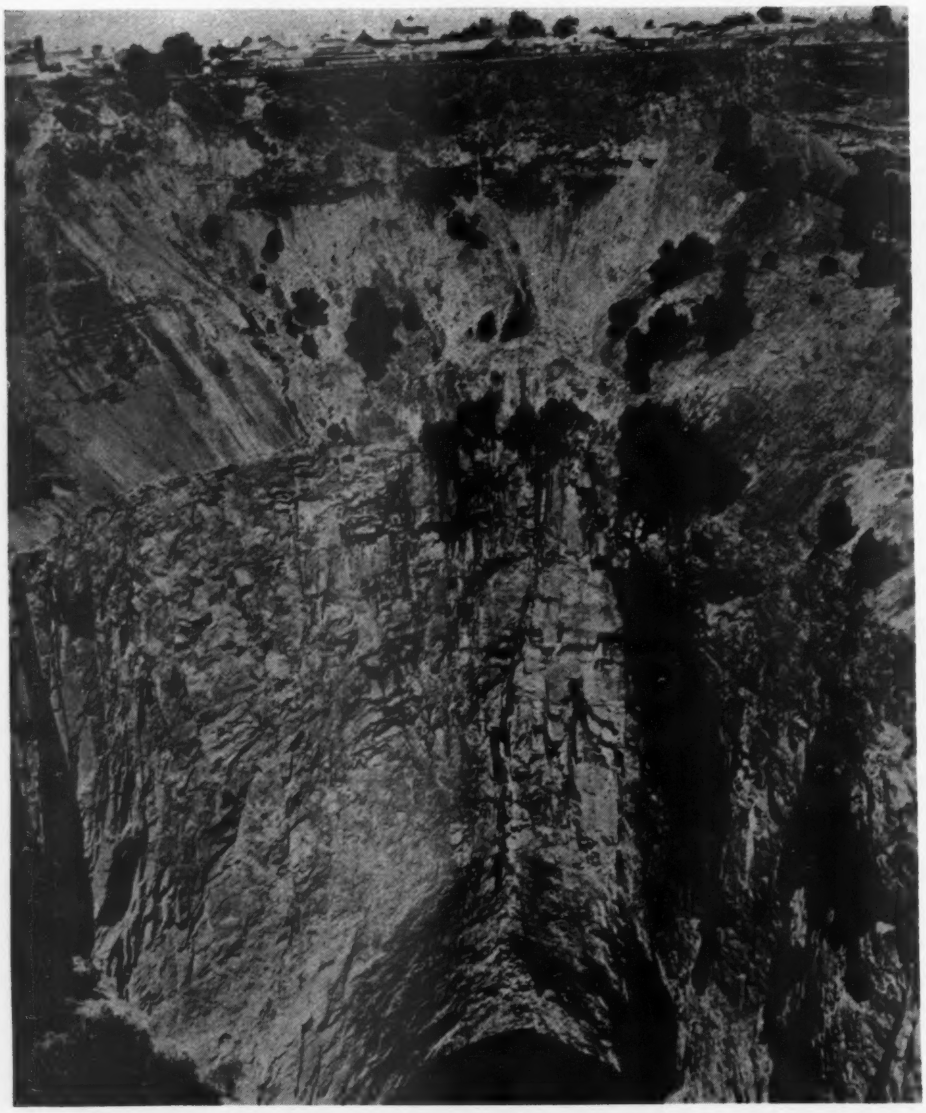
DIAMONDS might have been the turning point in the present war had France not capitulated when she did! Diamonds, whether used for personal adornment or as points on drills, have played some very important roles in this world. However, the most vital one ever assigned to them failed in its purpose because of the premature surrender of the French. It is rumored on good authority, though no one will accept responsibility for the report, that early last spring the French were drilling holes far underground from the Maginot Line toward the Siegfried Line with huge diamond-tipped drills that penetrated all obstacles. It was planned to load these holes with explosives and, at a given signal, to destroy the usefulness of the Siegfried Line by blasting—to render its guns ineffective by throwing them out of alignment so that their aim would no longer be true. Instead of that *denouement*, we know what happened. The holes were actually bored, so the story goes, and diamonds did their part only to have the plan frustrated by the frailty of human nature. That the Germans did not attempt a like feat can perhaps be attributed to the fact that they do not possess a sufficient quantity of the stones for drill points.

Man, industry, and science have put the diamond to many uses and, combined, are responsible for the exquisite shape, and for the polish and finish of the gem that is so highly prized by women. But in industry the stone has a far graver responsibility than that of serving as an ornament, for there it is an invaluable tool that promotes production.

That the diamond was known nearly 2,000 years ago is shown by certain writings, among them those of Pliny, who spoke of the rarity of the stone and called it "the most valuable of gems, known only to kings." The Romans are believed to have obtained their first diamonds from India, where they had probably been mined for several centuries. Roman writers who lived after Pliny mentioned that the sands of Indian rivers yielded the *adamas*, from which the present word "diamond" was derived through corruption.

A peculiarity of the diamond's occurrence is that it is nearly always found as a single crystal that shows no evidence that it was ever attached to a matrix. Until the opening of the underground mines in South Africa, almost all diamonds were obtained from river gravels. Because of the hardness of the stone, the crystals seldom showed any signs of wear and they were sometimes nearly perfect. The diamond crystallizes in the cubic system, and generally assumes the form of an octahedron, consisting of two pyramids, base to base. It may, however, occur in various other forms derived from octahedrons. The diamonds mined in South Africa commonly have rounded faces and many of them are imperfect crystals that apparently were intermediate forms—in other words, Nature did not complete her work on them.

The rounded faces and the dull greasy luster of their surfaces give newly mined diamonds the appearance of drops of gum or resin. Colorless stones are uncommon, there usually being some cloudiness, with faint tints of gray, brown, yellow, or white. More rare are red, green, brown, and black stones. The color can be removed by high temperatures, but it returns when the stone cools. As the hardest-known substance, the diamond is rated ten in the mineralogist's scale, although tantalum and some of its alloys closely approach it. Even diamonds vary somewhat in hardness, those from Borneo being said to exceed all others in this respect. The largest diamond of gem quality ever found was the Cullinan, discovered in 1905. It was cut into nine large stones, the four



THE GREAT PIT AT KIMBERLEY

The discovery of surficial diamonds at Kimberley, South Africa, in 1871 led to a great rush. The ground was divided into plots 31 feet square, and the sinking of pits was begun, the material being hoisted by buckets and windlasses. As the pits were deepened, haulage roads that had been left caved in and a network of aerial cableways was set up for transportation. Gradually the workings passed through the red surface soil, an underlying layer of "yellow earth," and then entered the "blue ground" from which most of the diamonds are now mined. Blue ground is of volcanic origin and occurs in the form of "pipes" that are usually of circular cross section. In 1889, when the Kimberley crater shown here had reached a depth of several hundred feet, Cecil Rhodes and Alfred Beit acquired control of it and other properties and consolidated them. They have since been operated by De Beers Consolidated Mines, Ltd. Mining of the pipes is now carried on by sinking shafts in the adjacent country rock and running lateral drifts into the diamantiferous ground.

largest ones weighing approximately 516, 309, 92, and 62 carats, respectively.

Let us trace a diamond to its source and see the many stages through which it passes before it becomes a costly jewel or a lowly drill tip. When one thinks of diamonds one instinctively associates them with the De Beers Consolidated Mines, Ltd., in South Africa and conjures up pictures of Kaffirs, of cavernous depths in the earth, and of mining paraphernalia. Everything about a South African diamond mine is very carefully guarded. Electrically charged barbed-wire fencing surrounds the property; and to further protect the treasures buried deep in the earth, alert armed men patrol the barriers 24 hours a day the year round, and they never relax their vigilance. But dependence is not wholly placed on human beings with their frailties. A number of specially trained Alsatian dogs keep faithful watch. These animals will tackle and bring down any intruder without inflicting physical harm and will stand over their quarry until relieved. Not only is the visitor with a pass watched by both guards and dogs, but the miners themselves are subjected to rigid scrutiny and searching.

Many a story of trickery resorted to in stealing is told about the simple Kaffir "boys" who worked the mines in days gone by. Swallowing the haul was one way. One worker could not "stomach" the theft and reported a stomachache to his "bass" only to have an operation that brought forth six diamonds weighing several carats! The more wily of them incised their legs or arms, thrust their loot into the wound, and bound it up. All manner of stunts were tried to smuggle stones out of the mines, and in the old days the "I.D.B's" (illicit diamond buyers) made good profits.

Today all that is changed. In addition to taking many precautions, the company pays a bonus to each boy who turns in a diamond of substantial size. To further safeguard its interests, each one is employed for a term, usually of six months, during which he works eight hours a day six days a week for a dollar a day, plus every native comfort that assures clean, healthy, and congenial surroundings. The miners live under continual surveillance in a "compound" in the wire-inclosed mining area. Some of the "boys" are small men with light-brown skins, others are tall, and as black as ebony. Between these two extremes are all manner of shapes and shades. Some talk one dialect, some another, for here is represented a cross section of South African humanity that includes Zulus, little Cape boys, members of the Xosa and Pondo tribes, and others. On festal days the compound members relive their spectacular ancient ceremonies. Tribal dances play a large part in these celebrations, and flourishing spears and shields, gaudy blankets, and ostrich plumes all add color to scenes of wild, unrestrained native rites.

At the end of his term of employment, each boy is kept in detention quarters for a week before he is allowed to go about his affairs outside the mining area. His belongings are searched, and he is subjected to the most rigid physical examination, even to X-raying to discover if there are any stones hidden in his body. The diamond, in comparison with other gems, is "transparent" to the X-ray; but, unfortunately for any thief, it shows up well when encased in body tissue. Nowadays, if a man is caught stealing, he is compelled to serve several months without pay in the mines until he loathes the sight of diamonds.

Diamonds in the rough have but little resemblance to the beautiful, gleaming stones in a jeweler's windows, so let us penetrate one of De Beers' great pipe mines and see what goes on underground. A great steel headframe rises over a shaft down which a square steel cage takes us below, 2,000 feet from God's sunlight. It is not one uninterrupted dark drop, for at intervals a light flicks by as our cage unhurriedly passes each level at which the mine is worked. Neither are we alone in the cage, for with us is our pleasant English guide and some workmen wearing little brass lamps affixed to their hats. Our guide tells us not to expect to see any dia-

monds: some of the miners who have toiled there for 30 years have never had that experience. Very rarely does one spot a bright stone sticking out of a piece of kimberlite, or blue ground or earth, even though diamonds may be all around.

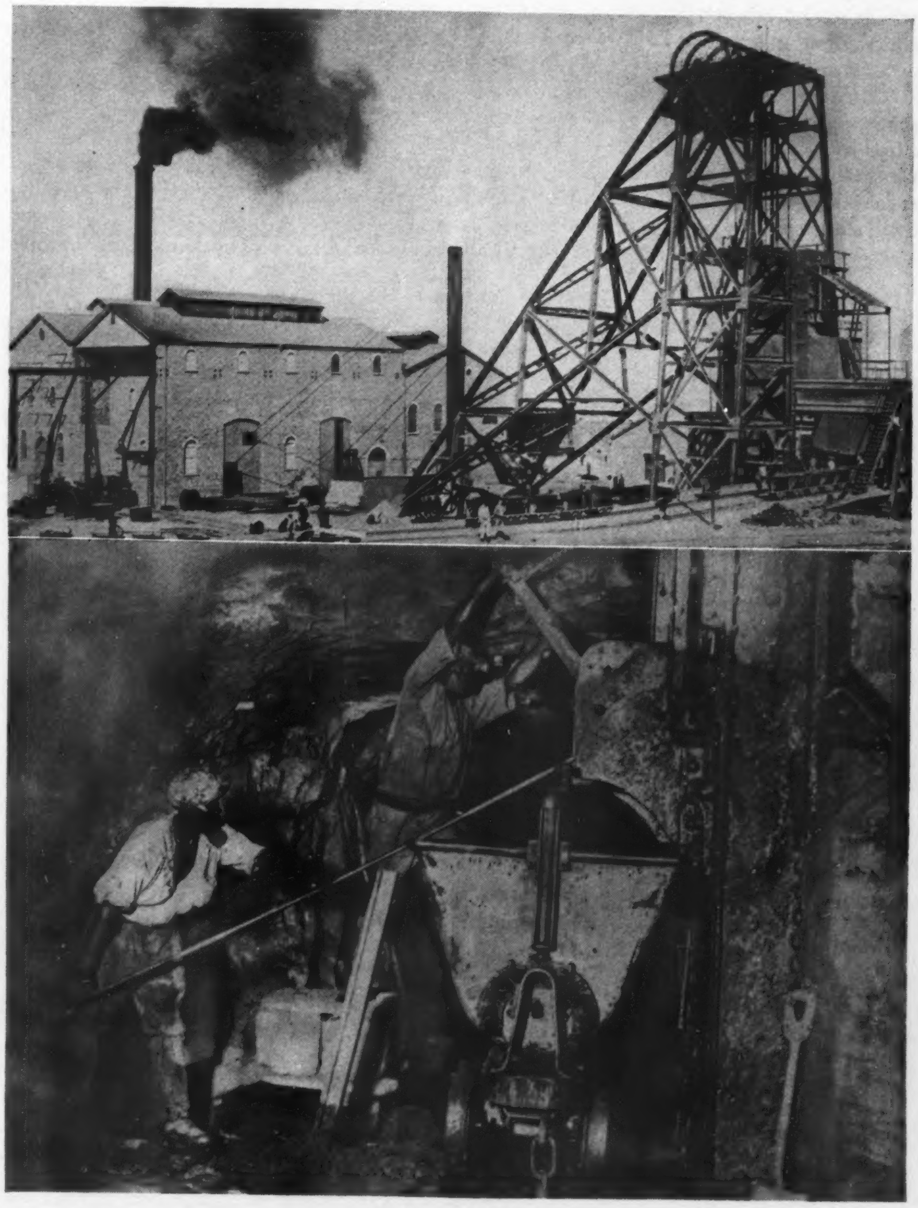
Arrived at the foot of the shaft, we see a long line of steel cars on rails. Each is loaded high with blocks of blue ground—a hard rocklike substance, as we discover upon handling it. On a parallel return track stands a trainload of empties. There is an air of hustle and bustle here in the bowels of the earth as great black Kaffir boys wheel up the loaded cars, dump the contents of each into a wide iron chute, and push away the empty one to join the line on the other track. As we stand, almost deafened by the noise of the tumbling kimberlite banging against the iron chute, another trainload rolls slowly down the slight incline of the drift to be unloaded with similar dispatch. The rock is discharged from the chute into steel skips of approximately the same size as the elevator cage. When one is full, it is hoisted up the shaft so fast that a man could not withstand the speed, for it is literally breath-taking.

Walking along the gallery, we notice that its solid walls are not of blue earth, the material we have just seen coming out of the chute. The inference is that we are not yet at the place where the diamonds are mined. We learn that we still have to go through nearly 1,000 feet of drift before reaching what is known as the "pipe," a vertical, cylindrical mass of volcanic agglomerate which is the source of the diamonds. On arriving at our destination we find ourselves in a single-track tunnel which is driven from one side of the pipe to the other. It is lined and supported by massive timbers which create the impression that things are becoming really dangerous—that there is a thrill to this diamond mining—that the blue ground is soft, treacherous, caves in easily. To add to the feeling of apprehension there is a tomb-like silence; and we observe that the timbers are dripping wet and covered with fungus. The air, too, is heavy and damp, and blows in a stiff breeze through the narrow passageways as it is being circulated by giant fans located on the surface.

Proceeding along the pipe we come to a widening of the tunnel and see kimberlite being loaded into cars from a chute into which it has been dumped from levels overhead. Every 40 feet, vertically, is a drift or blue-earth tunnel, but only every tenth one is connected with the shaft by a haulageway, which, our guide explains, is the reason why "blue" from the nine other levels must come down the chute before it can reach the skips.

Ahead of us lies a veritable maze of passageways grotesquely lighted by the ghostly yellow lamps on the hats of the miners. Flashing about in the dark as the men move around, they have the appearance of Gargantuan fireflies. The efficient sound of compressed-air drills is almost deafening in the confines of the tunnel as the men bore deep into the rock. The holes are loaded with dynamite cartridges; and precious kimberlite is blasted away as the heading is advanced a few feet deeper into Mother Earth.

Here, our guide tells us, we are at the end of a finished drift. One of the miners is busy loading a pile of broken blue ground into a small steel car. What's the source of the rock pile, we inquire? We are conducted to what is termed a "poleroad." It is just a hole in the wall and leads upward, with poles taking the place of steps, hence its name. Climbing up 20 feet, our hat lights reveal a gloomy stope about 20 feet wide by 50 feet long and of an average height of 6 feet. In it are two miners, one of whom is drilling holes in the solid-rock roof. We watch until he has finished twelve of them and has packed in each a cartridge of dynamite wrapped in wax paper. After the drill has been dismounted and taken by way of the poleroad to the tunnel below, each cartridge is connected by wire to a central battery. With all persons out of the stope, the charge is exploded with a dull thud, and a stream of acrid smoke floats heavily down to the level below. The miners continue to drill the roof until, one day, they find they have



MINING SCENES

The prevailing method of mining is to drive drifts, at vertical intervals of 40 feet, from the shaft to the boundary of the "pipe" of blue rock. Within the pipe a series of parallel drifts, about 100 feet apart, are driven to the junction with the country rock on the far side. Crosscuts are driven at regular intervals at right angles to the drifts. From this system of galleries stopes are opened up overhead. The soft blue ground is easy to drill and is shot with light charges of powder. The muck is chuted to a haulageway level, where it is drawn into cars (lower picture) that are trammed to the shaft and run on to a cage. Some mines employ skips that hold considerably more than a car. The upper view shows the headframe and surface buildings of a mine, with strings of loaded ore cars.

bored through to the surface. But their work goes on just the same, for they are sent to a new location where the operations are repeated.

There is nothing haphazard about diamond mining today, and under the able guidance of H.T. Dickinson, the American technical director of the De Beers Company's vast holdings, everything has been systematized. The drifts are driven at predetermined distances from one another to the far side of the pipe, and the stopes are located at regular intervals with pillars of rock between them. The latter are finally blasted out, and the rock above the drift is "sliced back" in such a manner that there is no possibility of a cave-in which might cut the miners off from the shaft, their only avenue of escape in such an eventuality.

The next stage in the operations takes place above ground. The contents of the skips are transported to a mill in which the material goes through massive, fluted crushing rolls which reduce it, step by step, until each particle is the size of a bean. These granules are then passed through flat and round screens of different types and sizes to great circular pans in which they are mixed with mud. At this point, rotating toothed arms sweep away the lighter particles before the mass is transferred to jigs or vats of water in which it is sloshed up and down by plungers. The light "ground" is washed over the rims of the jigs, and the heavy material is drawn off from the bottom of each vat. After this separating process, 99 per cent of the blue earth is hauled to a tailing dump and thrown away as worthless.

The concentrate—the heavy, valuable material—is conveyed to a long room in which there are nearly 100 oblong, inclined tables underneath a maze of belts, girders, and pulleys. Each table is thickly coated with yellow vaseline and is violently shaken from side to side by mechanical means. It is down these inclined surfaces that the concentrate is washed, tumbling off the lower end into a trough. Above the upper end of each table, hinged and padlocked to it, is a flat glass hood under which, sticking to the grease, are the precious sparklers. The tables are stopped twice daily and the hoods are lifted so that the vaseline and diamonds can be scraped off into perforated iron pots. These are immersed in boiling water to remove the grease from the stones; but the grease is not wasted, it is cooled and used over and over again. Perhaps only a handful of these little bits of carbon are gathered as a result of the day's processing of some 2,000 tons of kimberlite.

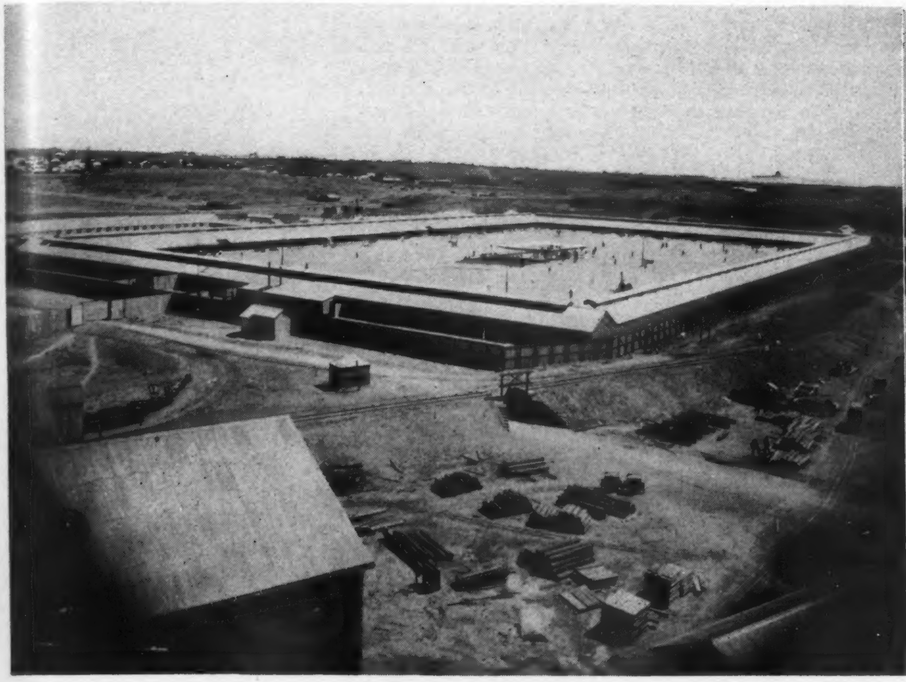
Chemically, a diamond is pure crystallized carbon the atoms in which have been compacted through the ages and aligned in definite patterns that give the stone great strength structurally. Socially, it is the most regal and valuable of jewels. Its great beauty is due to its optical properties, that is, the refraction which occurs when a light ray strikes the stone. The diamond leads every transparent substance in its index of refraction (2.42); and in cutting, every advantage is taken of this property, as well as of the high power of dispersion which separates the light into its spectral colors and gives the stone its "fire."

Man's skill in bringing out the full beauty of the diamond through the art of cutting had its inception more than 1,000 years ago among Hindu lapidaries. It was a technique handed down from father to son, a carefully guarded secret. In our times, Holland has for many years been the diamond-cutting center. In the late "sixties" of the last century, however, the industry was introduced in the United States, and today there are approximately 500 cutters in this specialized business in this country. These men are now doing practically all the diamond cutting in the world, because those in Holland have no gems to cut. In fact, we are by far the most important buyer of both gem and industrial stones, our purchases last year having reached a total value of $35,373,670.

The modern process of diamond cutting may be roughly divided into five steps. First, there is a careful inspection to locate flaws, to study lines of cleavage, to decide upon the style of cutting, and to mark the lines to be followed in India ink on the stone. Second, the diamond is mounted in hard cement, a groove is made by scratching the mounted stone with another diamond to indicate the direction of the proposed cleavage, and a cleaving iron is placed in the groove and struck a sharp blow with a hammer. If this is correctly done, the stone will break evenly in two pieces. Third, this process is sometimes supplemented by another one, by sawing with a rapidly revolving wheel impregnated with diamond dust and oil This technique is frequently followed in the case of a large stone. It is first split, and then the component sections are sawed into smaller pieces. Fourth, the diamond is roughly formed by cutting or bruting. For this purpose it is mounted in cement on the end of a motor-driven lathe turning at high speed. The cutter presses a second

MILLING EQUIPMENT

Formerly the blue ground, a soft rock, was pounded with mallets to crush it and was then hand sieved by natives to recover the diamonds. Later practice involved spreading the material on the ground, where it slowly disintegrated under the action of rain and sun, the process being quickened by running plows through it. Now the system of recovery is entirely mechanical. The blue rock is crushed, then placed with mud in the great circular pans shown here. Revolving, toothed arms sweep the lighter material away as it comes to the surface. Next the mass is treated in jigs, where it is sloshed up and down in water by plungers. The heavy particles, including the diamonds, remain on the bottom, while the lighter ones are washed over the rims of the jigs. The concentrate thus obtained is run, with water, over inclined, oscillating tables the upper or head ends of which are covered with vaseline. The diamonds, being nonwettable, are caught by the grease, the worthless material passing on. Metals such as hobnails from the shoes of miners also adhere to the grease. In order to demonstrate the effectiveness of the recovery system, mine officials sometimes ask a visitor to mark a small coin so he can identify it and to throw it in a car of muck underground. Later in the day, when he inspects the mill, the coin is handed back to him.



LIFE WITH THE NATIVES

Native miners sign up for a 6-month period, which is renewable if they so desire. During their employment, they live in a walled enclosure or compound (above). They celebrate festival days in full regalia (below). Alsatian dogs are on guard to thwart the escape of would-be diamond thieves. One of them is shown at the right being trained to mount the high wall of the compound.

diamond, securely imbedded in the end of a long stick, against the one in the lathe until the latter has the desired shape. Fifth comes polishing, which consists of cutting the numerous facets or planes so that the finished stone will have maximum brilliancy. The roughly shaped diamond is mounted in a mechanical holder, called a "dope," and is pressed against a rotating horizontal disk coated with diamond dust and olive oil. A "brilliant-cut" diamond has 58 facets, and while half the weight of the stone has been lost in the process of cutting and polishing, its value has been doubled.

Industrially, the diamond performs functions that make it invaluable. Without these stones it would be extremely difficult to manufacture such items of warfare as bombing planes, submarines, and machine guns, or such everyday necessities as automobiles and even dentists' drills. Fully 75 per cent of the diamonds imported by us are for industrial purposes. Two-fifths of them serve for the purpose of truing grinding wheels, as no other substance can be used to shape the hard surface of emery, carborundum, and tungsten carbide. In the manufacture of wire they also play an important part. In order to produce wire of uniform thickness, it is drawn through a round hole drilled in a diamond die; and a series of these dies, with progressively smaller holes, reduces the size and provides wire of any desired diameter. Geologists and mining engineers find diamond core drills indispensable in their exploratory work; and giant steel saws, the teeth of which are studded with hundreds of small diamonds, are employed in cutting dimensional building stone.

Diamonds are everywhere about us. In the home, perforated diamonds are fitted into the oil nozzles of oil burners. They are used in etching tools, in hardness-testing machines, for extruding graphite in making pencils, for turning ivory billiard balls and plastic doorknobs—in fact, the industrial applications of diamonds are myriad and contribute no small part to our everyday scheme of living.

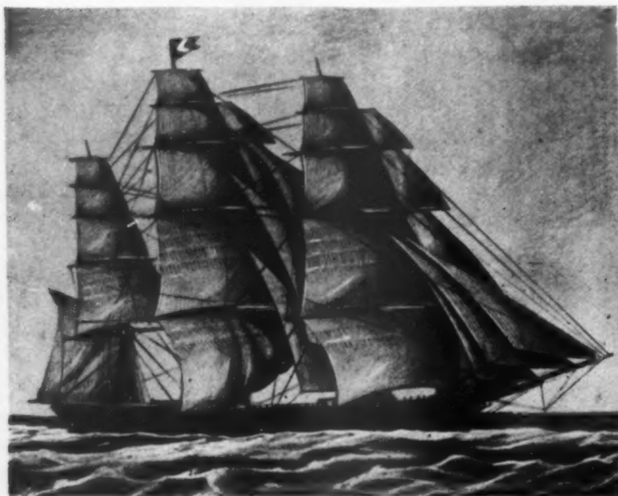
There are only a few diamond fields of commercial importance. The ancient Golconda fields in India are practically exhausted, and Brazil contributes possibly 3 per cent of the world's consumption. The remainder—more than 95 per cent—comes from Africa, the majority from the great pipe mines and fields in South Africa which are owned and controlled by De Beers Consolidated Mines, Ltd., of Kimberley. This organization and the Diamond Corporation of London supervise more than 95 per cent of the world's output. The Diamond Trading Company, capitalized at 2,000,000 pounds Sterling, all of which is invested in rough diamonds, controls the sale of all such stones. "Sights" are offered at frequent intervals to buyers whose names are on an approved list, so that close control is kept of all transactions.

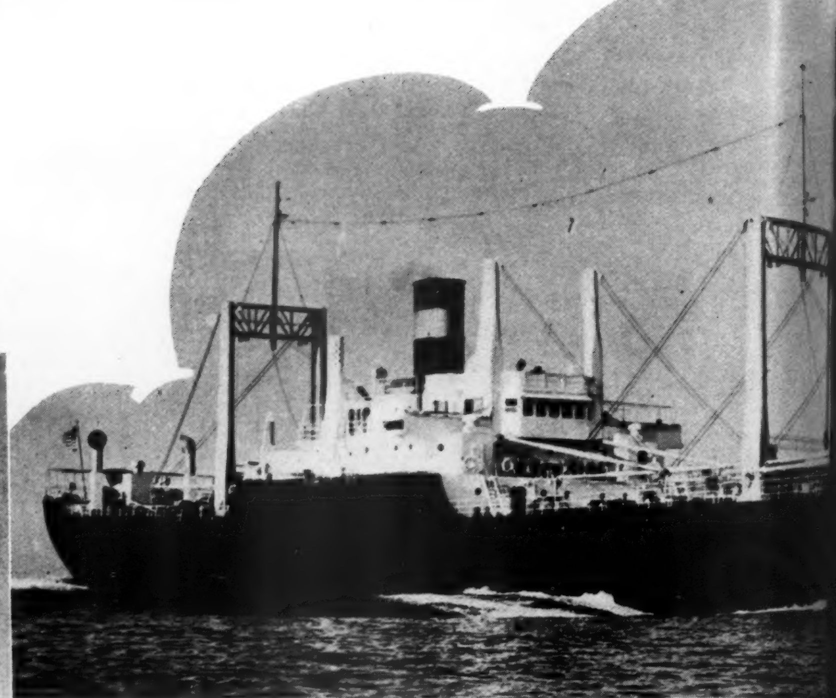
With the production and sale of diamonds functioning so smoothly, we in America need have no fear that industrial activities will be slowed down by reason of a shortage of these long-lived hard stones that are so invaluable to the proper functioning of manufacturing operations. Statistics compiled by the department of James W. Young, director of the U.S. Bureau of Foreign and Domestic Commerce, show conclusively that the supply will be sufficient to meet every requirement.

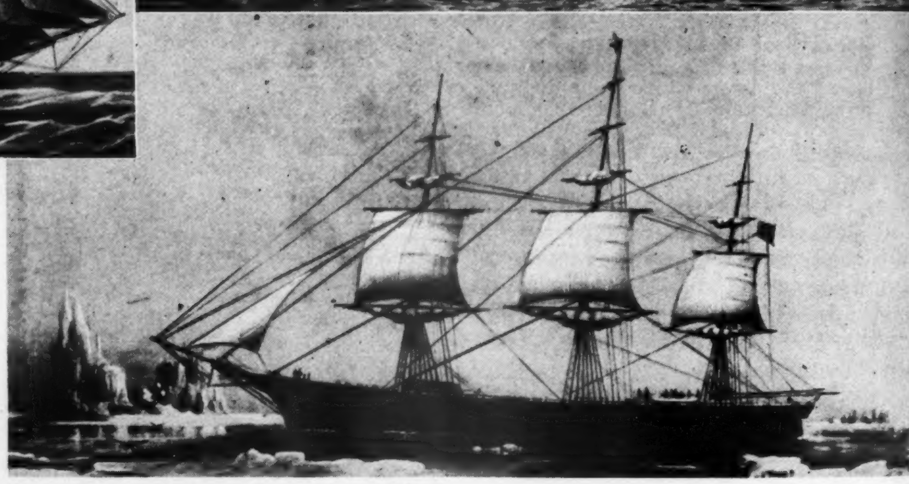
Ships to Win and Hold Overseas Trade

Robert G. Skerrett

Photos of C-2 ships from U.S. Maritime Commission and Federal Shipbuilding & Dry Dock Company.







EARLY CLIPPER SHIPS

Prints of two famous clipper ships of a bygone era. At the upper left is the "Flying Cloud" which was built by Donald McKay and sailed in 1851 from New York to San Francisco, around Cape Horn, in the then astonishingly short time of 89 days. The other view is of the "Red Jacket" which was built by George Thomas at Rockland, Me., in 1853-54. In 1854 she established a record of 13 days 1 hour on the run from New York to Liverpool. The picture shows her passing through an ice field off Cape Horn while on a homeward journey from Australia in 1854. On that voyage she carried 45,000 ounces of gold.

THE clipper ship is with us again! A score of them now adorn the expanding list of our merchant vessels. True, the revived, picturesque names are now borne not by sailing craft such as first made them famous but by twenty power-driven cargo carriers that represent the latest developments in naval architecture and marine engineering. These ships justify our pride and even enthusiasm.

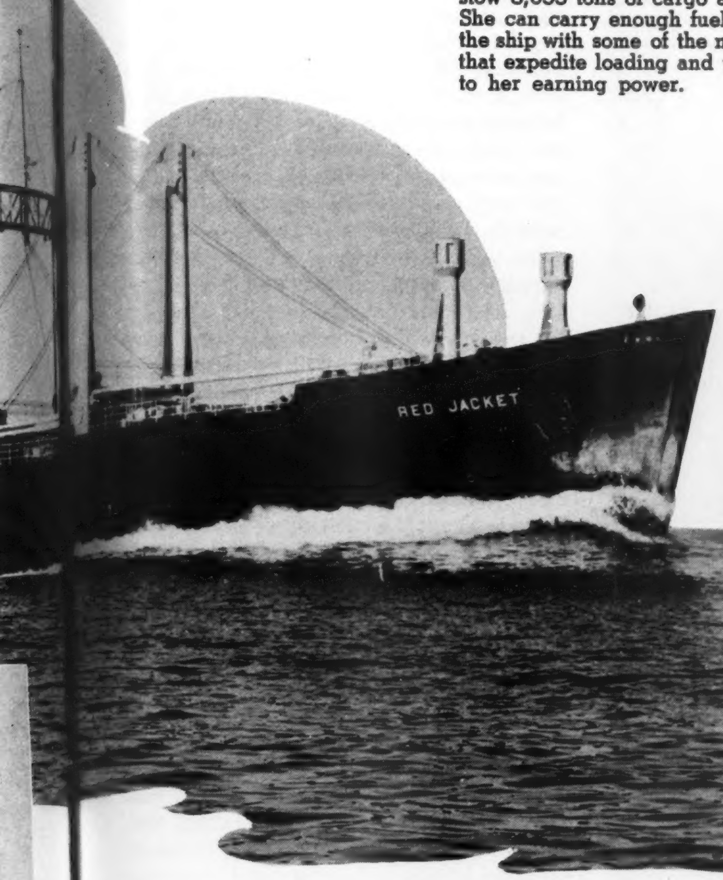
The U.S. Maritime Commission, with the authority vested in it by the Merchant Marine Act of 1936, has planned to build in the relatively short span of ten years 500 much needed merchant vessels for overseas service. Some of them are to carry passengers and express shipments; others are to transport both passengers and freight at lower speeds; but most of them are designed for the important comparatively fast freight service. In naming twenty of the large group of C-2 Type cargo carriers after historically noted clipper ships, the Commission has sought to remind us of what those vessels won for the nation during the period of their undisputed superiority in ocean-borne traffic, thus virtually promising to do everything in its power to restore to us the leadership we once held in foreign commerce.

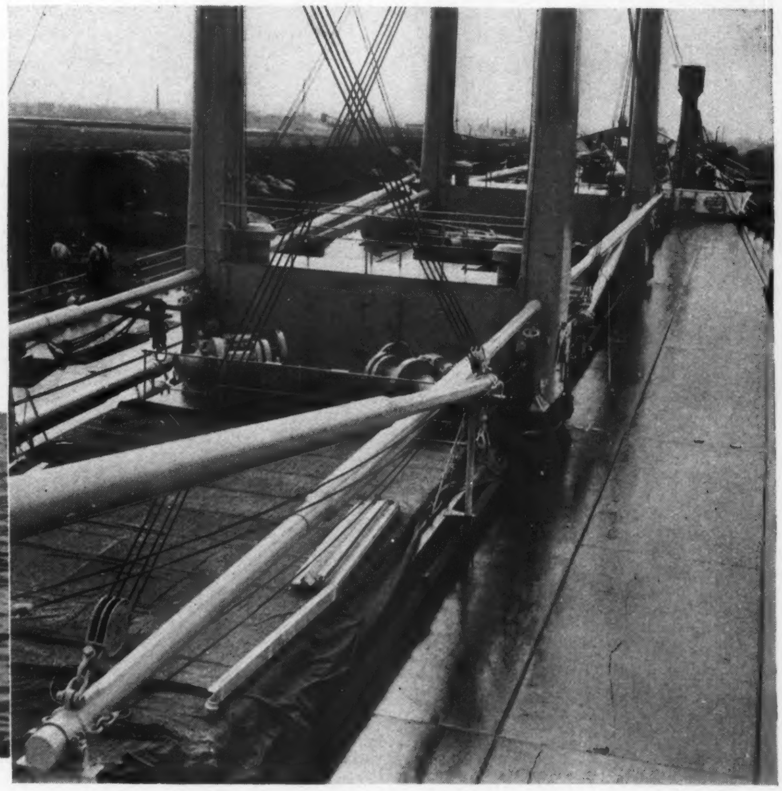
Our ship designers of nine decades ago displayed a rare gift in selecting those lines for a craft's underwater body that would best lend themselves to high speed under sail, to ample stability, and to providing generous cargo spaces. They brought into being what were known as "extreme clipper ships"—vessels that could carry enormous spreads of canvas when conditions favored and so fan themselves along in the lightest of breezes while others, by comparison, stood well-nigh still. Or when gales blew, those clippers, with a sufficient expanse of sail, could forge onward at a goodly pace instead of riding out the storm under nearly bare poles.

Not only were our extreme clipper ships exceptionally speedy but, ton for ton of displacement, they could carry larger cargoes than foreign vessels engaged in the same trade. Their successful performances were not entirely due to the display of cunning in designing and craftsmanship in building but were also the result of skill and courage shown by their commanders and subordinate officers in getting the utmost out of them. On ocean runs covering thousands of nautical miles they carried all possible sail at all times, and thus, by the fullest use of Nature's free winds, could make five voyages in a given period while ships under other flags, and perhaps less resolutely handled, could log but four. Our clippers of the "forties" and "fifties" of the last century were commonly able to get full cargoes and at much higher freight rates in foreign ports than were their slower competitors. No wonder, then, that the American clipper ship could earn her keep and even her building cost in a single voyage in various fields of serv-

THE S.S. "RED JACKET"

On her trial runs she made a maximum speed of 17.7 knots, in light condition. Like her numerous sister ships of the C-2 Type of cargo vessels, this freighter can stow 8,055 tons of cargo and maintain a speed of 15.5 knots when fully laden. She can carry enough fuel for 13,000 miles. Below is shown the main deck of the ship with some of the numerous cargo booms and electrically driven winches that expedite loading and unloading. This saves time at ports of call, and adds to her earning power.





ice. Those were the days when our clippers paid their way and earned rich rewards for their owners and operators. They won trade and held it. In that period the United States reached the peak of her commercial eminence upon the sea and American bottoms carried more than 90 per cent of all the nation's imports and exports.

The story of what happened to our shipping in foreign trade between that time and the outbreak of the World War cannot be told here: it is enough for us to know that the intervening decades marked a continual decline which reached its low point in 1914 when alien ships were our principal dependence and American bottoms transported but 10 per cent of our imports and exports. At that grave crisis, intensified by the abrupt withdrawal of foreign carriers, the Emergency Fleet Corporation was created and set the staggering task of making us self-sufficient in the matter of cargo craft. That organization constructed with remarkable dispatch about 2,500 vessels that cost approximately $3,000,000,000. That magnificent undertaking would amply have justified itself had the ships been designed not only to meet a wartime need but to make us capable of holding our own on the seas for years afterward. Most of them had an average speed of around 10 knots; and useful as they were during the conflict, they were later generally outclassed in world trade by better and faster cargo carriers built by other nations. The present aim of the U.S. Maritime Commission is to avoid that mistake. All the vessels that have been designed by it have been developed with the aid of the model experimental tank, and their final lines are such as to assure a maximum of desired speed with a minimum of power expenditure and operating cost.

The principal dimensions and general characteristics of our new steam-driven cargo carriers are given elsewhere in this article in tabular form. In the C-2 Type of craft the Commission will have ships that, because of their size, capacity, and designed full-load speed of 15½ knots, will give the American merchant marine what it most needs in the way of replacement. And to bring the meaning of this home to us, let us describe some of the fourteen of this type that the Federal Shipbuilding & Dry Dock Company has built and is building in its yard at Kearny, N.J. Six of them have been named after clipper ships that made records for themselves in the years of their prime. They are the *Challenge*, *Red Jacket*, *Flying Cloud*, *Flying Fish*, *Comet*, and *Lightning*. The original *Lightning*, said to have been the fastest sailing ship ever constructed, crossed the Atlantic from Boston to Liverpool in 1854 and attained an average speed of 18½ knots during one 24-hour run in which she covered 436 nautical miles. The *Lightning* was a full quarter of a century ahead of the first transatlantic steamship that could make 18 knots, which she did during a single hour on her trial trip.

The *Challenge*, which was contracted for early in June of 1938, was launched the following May, and her acceptance trials were run and she was delivered for service on July 10, 1939. The *Red Jacket*, which was awarded under the same contract, was put overboard after quick work and had her sea trials off Rockland, Me., during the second half of August, 1939. On her deep-water speed runs at light displacement she attained a maximum of 17.7 knots—virtually duplicating the performance of her sister ship, the *Challenge*. Each of these vessels exceeded by 2 knots the normal sea speed required at full-load draft; and the fuel consumption was at the remarkably low rate of 0.545 pound per shaft horsepower per hour. The specifications called for a fuel consumption of not more than 0.6 pound per shaft horsepower per hour; and because of the record made in this particular by the two ships, the Federal Shipbuilding & Dry Dock Company received $25,000 in each case—the maximum premium offered.

The significance of this fuel economy can be evaluated only when one is reminded that vessels of approximately equal

PROUD WINDJAMMER

Back in the 1840's, America startled the marine world by bringing forth a new line of sailing vessels—the clipper ships. Built on entirely new lines, these vessels were so trim and fast that they outdistanced even the steamships of their day. Setting unprecedented records for speed, they captured commerce wherever they went. America is again in the race for supremacy in cargo ships, as told in the accompanying article.

dead-weight cargo capacity, built by the Emergency Fleet Corporation during the World War period, burned 1.1 pounds of fuel oil per shaft horsepower per hour when making 10½ knots. That is to say, on half the fuel consumption, the new craft can make a speed per hour that is nearly 50 per cent higher. To be exact, the Emergency Fleet Corporation ships had a dead-weight cargo capacity of 8,000 tons, as against 9,758 tons for the *Red Jacket* and her class. On the basis of annual cargo-carrying capacity per barrel of fuel oil consumed, the C-2 Type are said to be 110 per cent better in potential performance than the Government freighters constructed twenty years ago.

Because of their speed, these new cargo carriers can appropriately bear the names of our extreme clipper ships; but in other respects they differ radically. Our historic clippers were built of timber, while those of today are of steel. Where the clippers were propelled by the free winds skillfully utilized, our modern vessels draw their driving power from within themselves and depend upon fuel oil mined from the bowels of the earth and fed to the boiler furnaces virtually under automatic control when the rate of feed is once fixed by the engineer in charge. The man on the bridge is no longer called upon to show the measure of resourcefulness to Nature's changing moods that our commanders did so abundantly when our clipper ships won fame on the Seven Seas. This is not by way of detraction, but merely to emphasize the changes that have come to pass and how engineering now takes precedence.

Perhaps the best evidence of what the *Challenge* and her class represent in the way of advance is the performance of that ship on a run to India and back in chance competition with the *Crown City*, an American freighter constructed two decades ago. The *Crown City* left the Port of New York on October 11, 1939. Her voyage took her across the Atlantic and through the Mediterranean, the Suez Canal, the Red Sea, and the Arabian Sea to Karachi at the northwestern limits of the west coast of India. From there she worked southward to Bombay and to Colombo on the Island of Ceylon, thence northward to Madras and Calcutta, returning to Colombo before heading homeward by way of the Indian Ocean, around the Cape of Good Hope at the southern tip of Africa, and the Atlantic. She arrived in New York about 9.30 a.m. on February 25, 1940. The *Challenge* left New York 26 days after the *Crown City*, followed the same route to India and back, and made the same stops. The new ship also entered the harbor on February 25, and only one hour and eighteen minutes behind the *Crown City*, outfooting the older vessel by virtually 26 days! This showing strikingly illustrates what the U.S. Maritime Commission has done in the case of its C-2 freighters. The *Crown City* returned with a full cargo of 6,000 tons and the *Challenge* with 7,000 tons of freight.

The foregoing facts are proof of how faithfully the shipyard carried out the contract specifications under which the *Challenge* was built, and are indicative of what we may expect from others of the type. But what, may be asked, has each of them down inside of her that makes such a performance possible? The *Red Jacket*, for example, is propelled by a General Electric turbine plant of the cross-compound impulse type. It is composed of a high-pressure turbine section and of a low-pressure turbine section connected by a system of double-reduction gears that drive a single shaft, transmitting the united propulsive energy to a solid-bronze propeller 19 feet in diameter and weighing 15.5 tons.

When the *Red Jacket* was on her speed trials and making a maximum of 17.7 knots, her propelling plant developed 6,793 shp. and the screw turned over at the rate of nearly 99 rpm. The impulse energy, in the form of high-pressure superheated steam, is furnished by two Foster Wheeler watertube boilers of the latest marine pattern and designed for an overall efficiency of 88 per cent at normal load operation. That is, the fullest present practicable use is made of the heat content—Btu's—available in each pound of fuel oil. Furthermore, the boilers, the turbines, and certain associate equipment are so interlinked that a relatively small percentage of the heat units escapes without doing helpful work; and the heat stored in the superheated steam is carefully conserved wherever possible and returned to the boilers so that the burners will have that much less to do in retransforming hot water into high-pressure steam to make another impulse circuit through the turbines.

The steam generated in the boilers is delivered to the high-pressure turbine section at a working pressure of 440 pounds per square inch—a pressure that was exceptional a few years ago even in high-speed express locomotives and at a superheated temperature of 740° F. The rotor of the high-pressure unit makes 6,100 rpm., while the low-pressure rotor makes 4,050 rpm.—the two, through the interposed

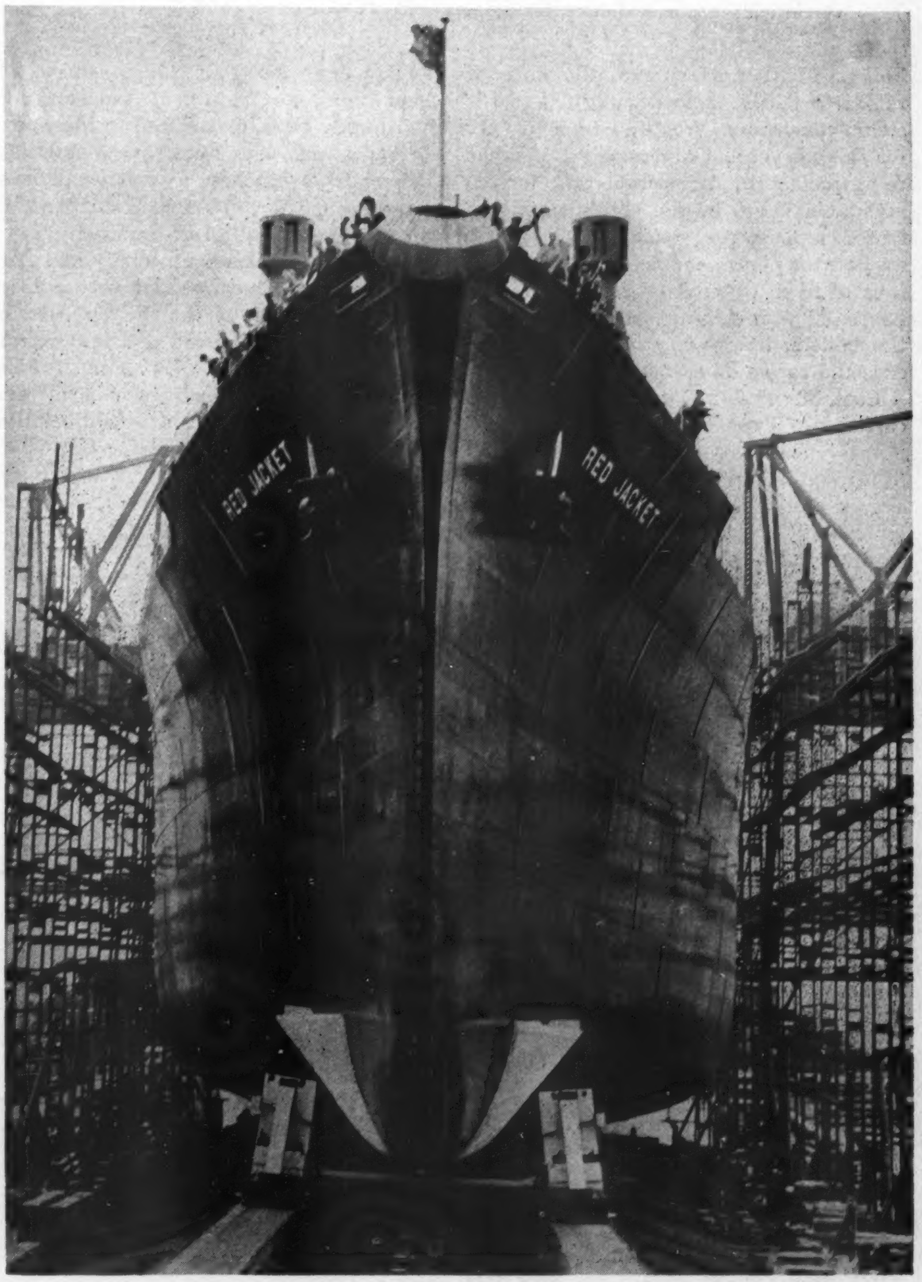
double-reduction gears, driving the propeller shaft in unison. Sturdily constructed thrust blocks tie the turbine plant and the driving shaft to the ship so that all of the tremendous impulse is transmitted to the propeller. The low-pressure turbine section exhausts its steam into a vacuum of 28.5 inches created in the main condenser where a continuous circulation of sea water chills the exhaust steam, robs it of its pressure by quickly returning it to a liquid state—really very hot water. The condenser is therefore a prime agency in promoting turbine efficiency and is required to condense the steam rapidly, and in large volume.

Each of the two boilers is capable of evaporating water and transforming it into high-pressure steam at the rate of 26,500 pounds every hour. To do this, each boiler has three automatically controlled burners which flash to incandescence in a regulated flow of preheated air. To make sure that the generated heat will not be dissipated through the boiler shell, all the walls, floor, and roof of the furnace are lined with a refractory material that is backed with insulation and cooled by a water-circulating system of tubing embedded in the walls so as to enable it to withstand longer exposure to the intense heat due to the efficient combustion of the oil fuel. The cooling water, which becomes hot water, eventually finds its way into the feed for the boilers, the acquired heat contributing to ultimate economy in generating impulse steam. Now let us return to the main condenser and follow the exhausted steam through to its conversion into hot water.

The main condenser is served by an Ingersoll-Rand Type 18VCM centrifugal circulating pump that has a capacity of 9,500 gpm. with an operating discharge pressure of 16.5 pounds per square inch. It is driven by a 75-hp. Westinghouse motor and takes water from the sea, sending it through the condenser to chill the nests of tubes carrying steam and then discharging it overboard. The condensate is picked up by two Ingersoll-Rand Type 2VHM 2-stage vertical centrifugal pumps each of which has a capacity of 120 gpm. with an operating discharge pressure of 67 pounds and is driven by a 15-hp. Westinghouse motor.

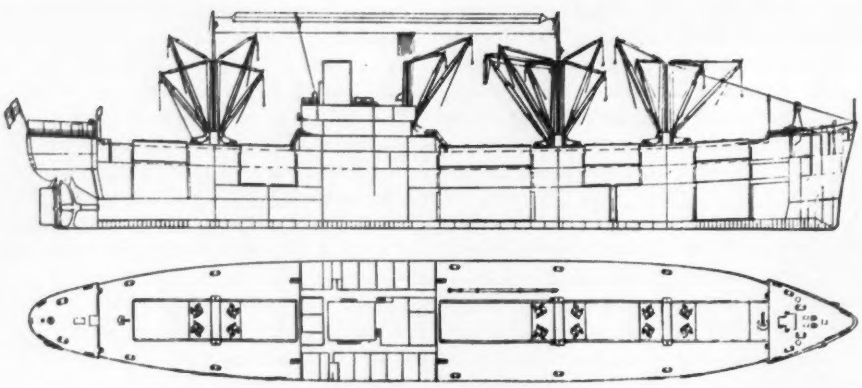
The discharge from the main condensate pumps is passed through inter- and aftercondensers associated with a 2-stage air ejector and condenses the operating steam of the ejector and the entrained condensable vapors. As a result of this heat transfer, the condensate undergoes a temperature rise, which corresponds to the first stage of feed-water heating. The purpose of extracting the free oxygen held in solution in the water before reconversion into steam is twofold: to prevent the gas from accumulating in the tubes of the condenser, as it would tend to block them and impair the unit's operation, and to check corrosion of boiler tubes and of other wet metal surfaces. The main condensate pumps deliver to a line leading to a deaerator where any free oxygen still present may be extracted and where the temperature of the water is further raised. The discharge from the deaerator is transmitted by a feed pump for reuse in the boilers.

Each C-2 Type cargo ship built and building by the Federal Shipbuilding & Dry Dock Company carries for harbor duty two 250-kw. geared auxiliary turbogenerators which furnish electric energy for various services while the vessel is in port. These turbines operate under steam conditions identical with those of the propulsion turbine plant and exhaust their steam into individual condensers at a vacuum of 28.5 inches. Water for the latter is supplied by a Type 8VCM auxiliary circulating pump that has a capacity of 1,450 gpm. with an operating discharge pressure of 18 pounds per square inch and is driven by a 15-hp. Westinghouse motor. The condensate is picked up by a Type 1MRV vertical, centrifugal pump that has a normal capacity of 30 gpm., can operate against a discharge pressure of 75 pounds per square inch, and is driven by a 5-hp. Westinghouse motor. In their working cycle, the air ejectors and the auxiliary condensate pump duplicate the operations just described for the main condensate pumps. Between the deaerator and the



ON THE WAYS

The "Red Jacket" ready for her initial plunge. The successful launching of a large ship climaxes months of preparation and carefully co-ordinated steps. The public is seldom aware of it, but the launching period of a ship is an anxious one for her builders.



INBOARD PROFILE AND MAIN DECK PLAN

The shelter-deck construction assures plenty of freeboard and enables the vessels to be driven steadily onward through strong seas and against high winds. The internal space is ample for motive power, fuel tanks, capacious cargo holds, and comfortable accommodations for officers and crew.

boilers, the temperature of the water is raised to 310°F. before being fed to the steam generators. Waste steam is utilized for this purpose. Only fresh water is fed to the boilers; and to compensate for unavoidable losses in the ship's supply of stored fresh water, each vessel has an evaporator plant capable of producing 30 tons of fresh water from sea water in 24 hours. The make-up water required for the boilers, however, probably does not exceed 5 tons a day when at sea.

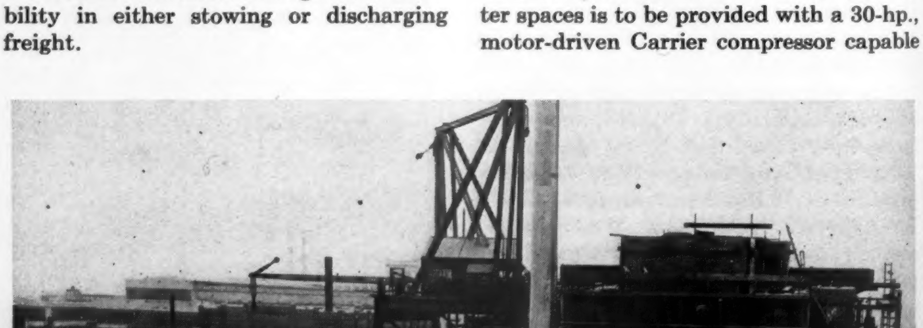
Each of the C-2 Type freighters also carries two Type 3VBM bilge and ballast pumps. These are single-stage units rated at 415 gpm. when operating at a discharge pressure of 33 pounds per square inch, and each is driven by a 15-hp. Westinghouse motor. The double-bottom spaces that can be drained by these pumps extend from the forward collision bulkhead aft to the forward end of the shaft-tunnel recess to which water may be admitted through damage to the bottom plating. There are deep tanks with a combined capacity of 3,462 tons in No.2 and No.4 holds. These are intended for either dry or oil cargoes, but may be used for water ballast should the ship be without cargo. It may be of interest to know that the main and auxiliary circulating pumps are also equipped with bilge suction as well as sea-chest connections so that they may be brought into service for pumping the bilges in an emergency.

The mariner is ever on the alert against fire, and as a means of dealing promptly with such a menace there is provided a Type 3VFM 2-stage fire pump of 400 gpm. capacity with a discharge pressure of 125 pounds per square inch. It is driven by a 50-hp. Westinghouse motor. A central priming system serves the bilge, ballast, and fire pumps. All these pumps have been designed by Ingersoll-Rand Company with careful regard to their use afloat where every pound must be saved and a practicable minimum of space occupied so that there will be that much more room for the carriage of money-making freight.

To enable the C-2's to load and to unload rapidly, a feature of importance in shortening time in port and in increasing income, each has numerous electrically driven cargo winches: fourteen capable of handling 6,720 pounds each at a rate of approximately 220 feet a minute and one that can handle loads up to 30 tons. The latter operates in connection with a boom 50 feet long set at the forward end of Hatch No. 3, and each of the others is served by a 5-ton, 55-foot boom. All the booms are constructed of drawn- and swaged-steel tubing. The entire installation is fitted to king posts placed where the booms will afford the greatest flexibility in either stowing or discharging freight.

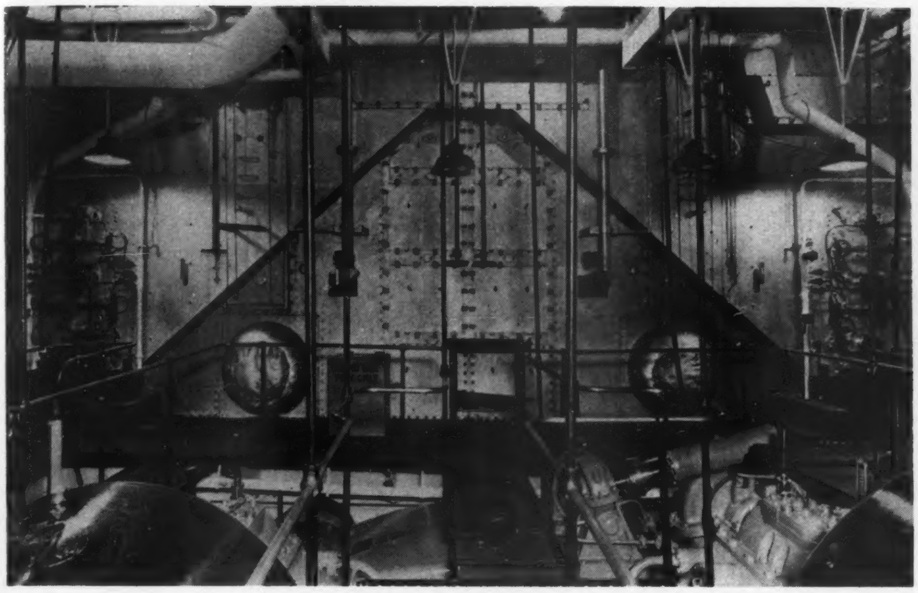
The refrigeration plants represent a marked advance upon the systems aboard other merchant vessels in established services. That on the S.S. *Challenge*, with 2,230 cubic feet of cold-storage space only for provisions for officers and crew, consists mainly of a 3-ton Freon compressor unit. In the cases of the *Red Jacket*, *Lightning*, and *Flying Cloud*, where both perishable foodstuffs and certain cargoes in transit are refrigerated, each has eight compartments with a combined stowage space of 44,880 cubic feet and a Freon-2 refrigerating unit in each compartment. There is a spare unit that is connected with the cooling coils leading to all the spaces. Individual Freon condensers handle the refrigerant for the different compartments, and three Ingersoll-Rand Type 1½UV all-bronze, centrifugal, circulating water pumps serve the condensers.

For Hull No. 179—not yet named—the refrigerating plant will differ from those on the sister ships already built at the Federal Shipbuilding & Dry Dock Company's yard. This craft is to be allocated to the Grace Line and will be used in tropical waters. She will have four cold-storage spaces with an aggregate capacity of 103,155 cubic feet. One compartment of 24,680 cubic feet may be used for the transportation of either fresh meat or bananas, while the others—having capacities of 24,680, 26,605, and 27,-190 cubic feet, respectively, are intended exclusively for bananas. Each of the latter spaces is to be provided with a 30-hp., motor-driven Carrier compressor capable



UNDER CONSTRUCTION

The S.S. "Red Jacket" while still on the ways and about half completed. Many large structural parts were prefabricated in the yard and then hoisted into position and bound in place with rivets. By this procedure it has been possible to shorten the time of building—about 6½ months between keel laying and launching being the record construction period up to date.



ENGINE ROOM

The high-pressure boilers form the apparent bulkhead in the background and the tops of the propelling turbines are shown in the foreground. The boilers generate steam at a maximum pressure of 465 pounds at the superheater outlet and the propelling turbine plant is capable of developing a continuous output of 6,600 shp. when the propeller is making 92 rpm.

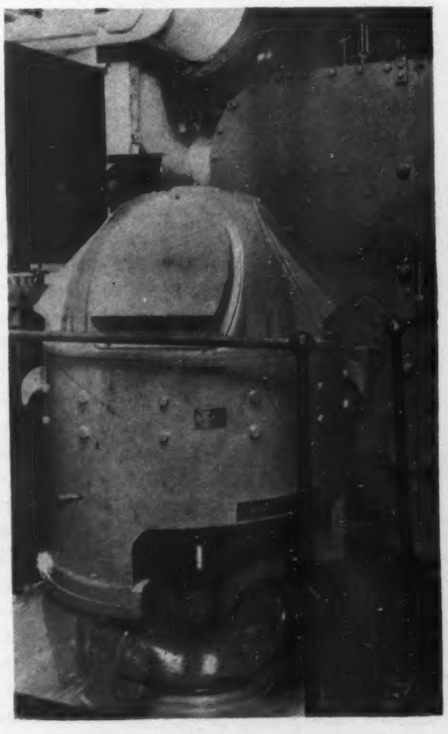
of maintaining a minimum temperature of 53°F., while the meat or banana compartment is to be served by two 50-hp. installations of the same type capable of maintaining temperatures from 0°F. upward. One of the 50-hp. units may also act as a standby, in case of need, for one or another of the banana compartments. Two Ingersoll-Rand Type 5VCM pumps will furnish the circulating water for the condensers of the refrigerating plant of this particular vessel.

To avoid adding to the demands on the ship's boilers either while in port or underway, the primary source of power for the various electrically operated units of the refrigerating installation on Hull No.179 is an Ingersoll-Rand Type S 8-cylinder, 10½x12-inch diesel engine driving a generator rated at 350 kw. or 505 hp. The latter will furnish direct current at 120 to 240 volts to the Carrier compressors, the circulating pumps, and a 4&2½x2¾ Type 30 compressor that will supply air at 250 pounds pressure for starting the oil engine. Each of the aforementioned circulating pumps will have a capacity of 900 gpm. at a discharge pressure of 17.5 pounds per square inch and will be driven by a 15-hp. motor. The refrigerating plant will also include a 3-hp. Type 2RV fresh-water circulating pump having a capacity of 180 gpm. at a discharge pressure of 21.5 pounds per square inch.

The officers and crew of any of these C-2 Type cargo carriers have comfortable and commodious quarters, with hot and cold water and other modern facilities. There are separate mess and recreation rooms for the petty officers and the crew; and a conveniently placed pantry will supply snacks between meals. The ships bearing the names of clippers are thus a striking contrast to those vessels under sail which made America famous in foreign trade many decades back. Then our sailors had to be content with such dietary staples as hardtack, salt horse, and sowbelly, with occasional variations in the form of sea pie and plum duff.

The Federal Shipbuilding & Dry Dock Company established its plant at Kearny, N.J., in 1917, to build ships for the Emergency Fleet Corporation, and by the early part of October of the succeeding year had completed 30 vessels for the Government. The yard has been in continual operation ever since, and in 1937 launched its 150th hull. It has been maintained in an efficient condition ever since, and latterly the number of its shipways has been increased so that it can construct simultaneously nine or ten craft. Also, some of its shops have been adapted for fabricating large structural sections or members so that they can be moved and put in place bodily in a growing hull instead of piecemeal and at a slower rate, as formerly. This partly explains why the interval between keel laying and launching of the C-2 freighters has grown shorter and shorter, the best record so far being about 6½ months.

The yard's fine performances may be attributed to the leadership of experienced foremen who have been with the company for years; and back of these "top sergeants" of the respective production sections are the experts in the various technical and administrative divisions. This shipyard on the Hackensack River now has a working force of nearly 10,000, and is strenuously engaged in turning out vessels not only for the U.S. Maritime Commission but for the United States Navy—thus strengthening the nation in two essential directions upon the sea.



MAIN CIRCULATING PUMP

This Class 18VCM centrifugal pump enables the main condenser to take exhaust steam from the propelling turbines and to increase their efficiency by maintaining a vacuum of 28.5 inches by instantly transforming the steam into hot water. This essential action results from driving sea water continuously through the condenser at a rate of 9,500 gpm.

DIMENSIONS AND CHARACTERISTICS OF C-2 TYPE SHIPS

Length, over all	459 ft. 2½ in.
Length, on water line (between perpendiculars)	439 " 0 "
Beam, extreme	63 " 2 "
Depth, molded to shelter deck	25 " 10⅞"
Normal sea speed on load draft (Average condition)	15½ knots
Normal shaft horsepower	6,000
Displacement of load draft, approximate	13,900 tons
Gross tonnage	6,085 "
Net tonnage	3,573 "
Cargo dead weight	9,758 "

Sand-Ballasting on the Chicago Subway

Raymond T. Davis

IN THE construction of the State Street section of the new Chicago subway, especial care was taken to safeguard lives and property. As described in the August, 1940, issue of COMPRESSED AIR MAGAZINE, twin tubes were driven by the shield method, under air pressure, through clay of high moisture content. The street, which is one of the busiest in the city, is flanked with large and high buildings.

Scores of utility vaults and manholes are located in State Street, most of them owned and operated by the Commonwealth Edison Company or by the Illinois Bell Telephone Company. These concrete-lined trenches house the various high-voltage cables and networks of the light, power, and communication systems serving the business district. Many of these roomlike vaults are well over 20 feet deep, allowing in many cases only a foot of clearance between the floor of the vault and the top of the subway shields.

The wet, blue clay in this area of Chicago contains as much as 50 per cent water and is dangerous, shifting soil. In driving the tubes, air pressure up to almost 15 pounds served the dual purpose of providing support against cave-ins and of preventing excess seepage of water into the workings. While the compressed air was primarily a protective agency, there was the possibility that it might produce a "blow" as shield mining approached the deep utility vaults where the tunnel would have only a shallow earth roof.

To guard against shield pressure causing the utility vaults to "float," and to protect floor slabs in sub-basements from damage, the city engineers directed the liberal use of sand ballast. Details of the procedure followed were worked out by Lou Salmons and C.A. Hart, technical engineers for the Healy Subway Construction Corporation, and were approved by city engineers. This ballast was placed in such quantities and in such ways that its weight compensated for the pressure exerted by the shield that otherwise would have tended to push the vaults upward.

While a shield was cautiously advanced beneath a deep vault, city engineers on the surface measured its elevation at 15-minute intervals with a surveyor's level capable of determining differences in elevation within $\frac{1}{8}$ inch. Operating from an observation trailer equipped with a telephone and a siren-switch, the engineers kept in communication with the underground crew, notifying them of any change in street conditions. In the event of a sudden rise of the paving or of a vault in excess of 2 inches, they pressed a button that actuated a loud warning siren in the tunnel heading, halting all work immediately. The pockets of the shield were then adjusted according to the surface conditions before the shield resumed its shoving.

The contractor's original plans called for the lowering of about 1,000 fifty-pound sandbags into the average deep vault while a shield was underneath it. However, as the shields approached the Loop District, it was foreseen that the close proximity of sub-basements to the work would not allow the shield pressure to be dissipated through the ground. As a result, almost direct pressure was exerted upward against floor slabs, which were not designed to withstand such loading. In order to protect the sub-basements, it was not only necessary to place ballast on the curb retaining walls and on the floor slabs of the basements of public property but also on the floor slabs of private property that formed an integral part of the buildings outside of the private-property line.

HOLDING DOWN STATE STREET

1—Bags of sand piled 5 feet high and 6 feet wide in front of a motion-picture theater to keep the curb wall from rising as the shields passed underneath. 2—Ballast piled in the basement of one of the city's large department stores. 3—Workmen removing bags of sand from a utility vault with an Ingersoll-Rand single-drum Utility air hoist. 4—An engineer on the surface sighting through a level to detect any upward movement of a utility vault. Observations were made at 15-minute intervals, and if a rise of 2 inches or more was noted, a button was pushed that sounded a siren in the tunnel and halted the advance of the shields until ballast could be placed. 5—Workmen with an air-operated paving breaker cutting an opening through the street surface into a basement preparatory to lowering sandbags.

Two work crews were formed and placed under the supervision of Street Superintendent William Jones. One of these crews was engaged exclusively in preparing hazardous areas along the subway right of way for the passing of the shields. Large water mains were freed from the concrete walls of buildings so that slight street movements caused by the shields would not distort them to the breaking point. In the case of the deeper utility vaults, holes were drilled in their end walls with Ingersoll-Rand Jackhamers for placing lengths of strong reinforcing steel to bolster the thick, concrete floors which were poured later. These strong, reinforced-concrete floors stoutly resisted the pressure incident to the shield operations.

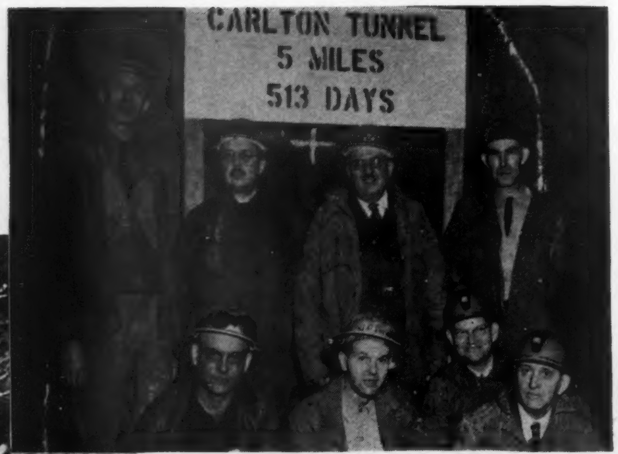
The second crew of more than twelve laborers loaded the utility vaults with as much as 50 tons of sandbags each. The bags were slid down a steel chute into the waiting hands of workmen who piled them neatly throughout the length of each vault. The sand crews toiled only at night so as not to conflict with the daytime hordes of shoppers and office workers. For removing the bags from a vault or a basement, there was erected over the opening a tripod on which was mounted an Ingersoll-Rand air hoist. Compressed air for operating it was supplied by an I-R portable compressor of 60 cfm. capacity. The hoist lifted 300 pounds of bags at a time. Basements were entered by cutting holes in the sidewalk, and these were repaired with fresh concrete when the work was completed. It was estimated that the hoist handled about 10,000 tons of sand ballast in less than a year's time and without a breakdown. The compressor was operated about twenty hours a day by both crews in the hot, sultry summer temperatures and again in the near-zero weather of November and December.

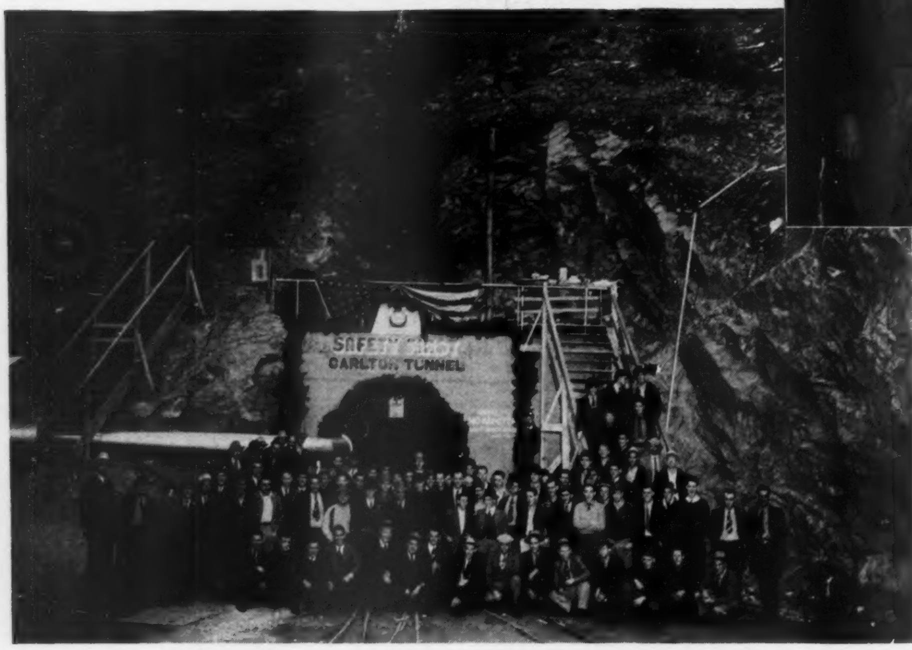
The biggest individual job handled by the sand-ballast crew was the placing and the removal later of almost 300 tons of loose sand in the second sub-basement of the Chicago Building at State and Madison streets, one of the world's busiest corners. The material was shoveled through a series of holes cut in the sidewalk, and fell more than 40 feet to the basement floor. Laborers packed it 6 feet deep throughout the length of this extension to prevent any upheaval from shield pressure. At this intersection the shields had to make a slight inward turn in following the exact contours of the street, which edges in at this corner. Because there was only a slight clearance between the thick curb retaining wall and the side of the nearest shield, workmen cut out a section of this wall beforehand, as the city and the contractor's engineers had decided to take no chances. Aided by the vast amount of sand ballast, shield operators cautiously jockeyed the huge cutter past this hazard, thus avoiding any serious mishaps. When the pair of shields had progressed past Madison Street, the work was easier, comparatively speaking. State Street widens at this point, and with the shields following a path down the center, pressure against the basements was reduced.

After the sandbags had served their purpose, they were used to load the sidewalks nearest the curb walls as the shields moved past. This excess weight kept the walls from shifting upward, avoiding cracks that might admit water to basements.

The actual shield-method work on the State Street section was completed about January 15. It marked the end of a tunnel-ing project which, until recently, was believed to be well-nigh impossible.

Carlton Tunnel Reaches 5-Mile Mark





CARLTON'S CHRISTMAS

The tunnel portal was decked out in festive garb for the joint celebration of Christmas and the reaching of the 5-mile mark in the bore. Every man on the job attended, and all are seen at the left, together with Cripple Creek mining officials. One of the workmen donned a Santa Claus costume to distribute to his fellows gifts provided with funds previously set aside from their wages and added to by Supt. John R. Austin. Each worker received, among other things, a 10-pound turkey that had been dressed and frozen for the occasion. The view above shows a group at the tunnel heading while on an inspection trip. Top row, left to right, are: John R. Austin, tunnel superintendent; O. P. Tanner, New York; Merril E. Shoup, president of the Golden Cycle Corporation which is driving the tunnel; A. H. Bebee, manger of the Carlton mines in Cripple Creek. Bottom row: Robert Welch, tunnel master mechanic; J. G. Farmer, tunnel engineer; Max Bowen, manager of the Golden Cycle mill, Colorado City; and David Strickler.

THE Carlton Drainage Tunnel, which is being driven under the gold-bearing area at Cripple Creek, Colo., to dewater the mines and to enable them to work at deeper levels, was 5 miles in from the portal at eight o'clock on the morning of December 23, 1940. This advance of 26,400 feet from one point of access in 513 working days established an all-time record for tunneling. The average daily progress was 51.46 feet. Excluding the first few weeks, when the procedure and crews were being organized and the bore was in fractured rock that required the erection of supports, the figures are still more impressive. During the 465 working days starting on September 6, 1939, the average daily advance was 53.22 feet, and on no day was it under 40 feet.

As projected, the main tunnel will be 32,000 feet long when completed and will terminate directly underneath the Portland No. 2 Shaft, which is the deepest in the district. Eventually it may be continued to a point under the Vindicator Mine, and a lateral may also be driven to undercut the Cresson Mine. Each of these supplementary bores would be between 4,000 and 5,000 feet long, and in all probability will not be undertaken until after it is known what effect the main tunnel will have on the general groundwater level in the mining area. There is a possibility that they may not be required.

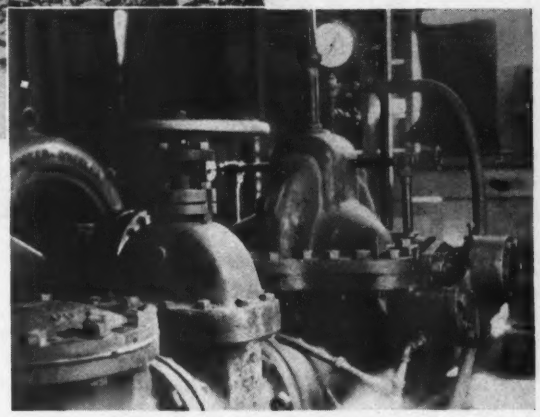
On its way to the Portland property, the tunnel will pass beneath the Ajax Mine. The Newmarket vein of that property will, it is expected, be reached when the bore is about 28,000 feet long, and drainage of the deep workings of the Ajax should start during February. Preparations are already underway to resume work as soon as practicable at the deeper levels, which are now flooded.

The Cripple Creek District, once the nation's leading gold producer, is already showing increased activity in anticipation of the revival of deep-zone mining that will undoubtedly follow the completion of the tunnel. Current production is coming from horizons above the level of the Roosevelt Tunnel, which is approximately 1,140 feet higher than the Carlton Tunnel line. Preliminary figures for 1940 place the output at 485,595 tons of ore averaging \$9.01 in gold content and aggregating \$4,378,852.91 in value. Of this the Cresson, long the most profitable mine in the district, produced 113,500 tons, worth \$1,165,000.

Inasmuch as the tunnel crews reached the 5-mile point during the Christmas season, the two events were jointly celebrated. A 4-day holiday was declared, and was especially welcomed by the men in view of the fact that they had been working since July, 1939, with scarcely a break in the 7-day-week routine. Some of the features of the celebration are shown in the accompanying pictures. Statistics, compiled by Supt. John R. Austin and covering the tunnel's progress up to that point follow:

Mile	First	Second	Third	Fourth	Fifth
Time timbering, hrs.	160½	None	None	None	None
Time drilling, hrs.	1,463¼	1,488¾	1,236½	1,113¼	1,232¼
Time mucking, hrs.	1,280¼	1,103¼	1,067½	1,142½	1,023½
Material excavated, cu. yds.	20,437	19,661	20,069	20,290	19,569
Cars, 3-cu.-yd., mucked	11,165	9,341	9,397	9,594	9,091
Powder used, lbs.	128,667	189,079	183,189	171,695	181,104
Powder per foot, lbs.	24.4	35.8	34.7	32.5	34.3
Number of caps used	26,395	26,356	25,243	26,248	26,030
Caps used per foot	4.98	4.99	4.78	4.97	4.93
Number of rounds	889.71	823.35	659.71	642.21	624.68
Advance per round, ft.	5.93	6.33	8.00	8.22	8.45
Working days	121	108	96	94	94

Sluicing the Nantahala Dam Abutments



PROGRESS VIEWS
A general view of the left abutment about two weeks after work was begun; a jet from a No. 2 nozzle cutting soft rock; and one of the two Cameron pumps that supplied water for the operations.

THIRTY-FIVE tons of water per minute were "shot" from two hydraulic monitors in a major stripping operation recently completed by The Utah Construction Company in North Carolina. These powerful jets were directed against the earth and loose rock on steep hillsides forming the abutments of a 250-foot rock-fill dam being constructed for The Nantahala Power & Light Company near the borders of the Great Smoky Mountains National Park. This typical Southern Appalachian dam site was inaccessible to mechanical earth-moving equipment because of the high slope of the ground surface, ledge-rock outcrops and large boulders, and a relatively shallow overburden.

The water for sluicing was pumped from the Nantahala River by two Cameron Class ALV, single-stage centrifugal pumps, each rated at 4,210 gpm. at a 275-foot head and driven at 1,750 rpm. by a direct-connected, 350-hp. Crocker-Wheeler motor. Current was supplied by a 2,300-volt parkway cable strung from a convenient substation. A 54x42-inch timber intake flume was located about 200 feet upstream from the limits of the dam toe and was provided with three sets of inclined screens to keep leaves and other river-carried material from clogging the suction pipes. The main sump, likewise of timber construction, measured 6x6 feet, and each pump had a 12-inch suction pipe. Ten- and 12-inch discharge lines were laid, as needed, to the wyes and branches of the distribution lines.

Protection from back pressure on the lines was furnished by cast-iron check valves placed ahead of each pump. Gate valves also were used at the pumps and at branch connections: light-weight, 1-way valves of the type commonly transported by airplanes to remote sluicing operations served in part on the discharge lines and standard heavy-duty valves elsewhere. All fittings were flange connected; but the main distribution pipe was connected by Victaulic couplings. Wyes, bends, and 8-inch pipe reducers were field welded. Altogether, there were 2,300 feet of 10- and 12-inch pipe of spiral-welded construction and about 700 feet of 8-inch slip-joint pipe for short extensions.

At the discharge end, the No. 2 Giant or nozzle was fitted with a deflector that allowed effective 1-man control of the direction of the jet. The nozzles employed varied from 2½ to 4 inches, depending upon the discharge and friction head encountered and upon the type of overburden moved. With about 80 pounds pressure at the nozzle, the smaller size was used for cutting the earth away from rocks and crevices, while the bigger one was installed when the washing or ground-sluicing operations involved the handling of large volumes of material.

The first major step in setting up the plant was that of running the main 10-inch feeder across the river bottom to the left abutment. There a sound anchorage was obtained, and the pipe withstood normal river currents and minor floods. All pipe and fittings were strung and moved around on the slopes by labor crews, one monitor being set up while the other was working. Wherever the contours of the ground and the area permitted, two "guns" were used at the same time, each on separate pumps and lines. At the height of the job, a total of 143 pump-hours, at an average head of 170 feet, was recorded during a week's work, and in that period about 4,300 square yards of abutment were cleaned and close to 8,600 cubic yards of material moved.

All equipment was hauled 15 miles from the nearest railroad siding at Andrews, N. C., in August, 1940, and set up as soon as practicable. By the middle of October, 21,000 square yards of foundation had been prepared at the site of the left abutment. At the end of November, approximately 50,000 square yards had been stripped on both sides. The overburden averaged about 6 feet deep and was difficult to move in many places because of the thick mat of roots and vegetation and the overlying loose rock. Wherever possible, particularly on the lower slopes, the surface of the ground was grubbed and loosened by a tractor with a bulldozer blade. In other sections hand grubbing was required and stumps and large rocks were blasted.

The sluicing was under the direct supervision of J. E. Bannister of The Utah Construction Company, with George R. Putnam as general superintendent, A. H. Ayers as job manager, and Philip H. Kline as job engineer. J. J. Baker is resident engineer for The Nantahala Power & Light Company, and J. P. Growdon is chief hydraulic engineer for the Aluminum Company of America, which will utilize the power to be generated at the dam.

INDUSTRIAL GEMS

FROM time immemorial, gem stones have been prized chiefly as personal ornaments. The different kinds have, in general, been valued according to their relative scarcity, although other factors have also had their influence. It happens that the scarcest gems are those of the greatest hardness. The fashion in personal jewelry has run parallel with man's ability to shape materials into usable articles. Primitive races had to be content to adorn themselves with soft ones such as bone or wood that they could pierce like beads for stringing, or work into desired forms. The harder stones were perhaps collected and treasured for their scintillating colors or brilliance; but their utilization had to await the development of the lapidary's art. Being the most difficult one to cope with, the diamond did not rise to full esteem until methods were devised for cutting and polishing it so as to bring out its peerless beauty.

For every high-quality gem stone that Nature has produced she has made many inferior ones. For a long time these secondary creations were practically valueless; but in recent years they have become of great service in industry. Despite their lower intrinsic value, they are right now worth more to mankind than the aristocratic brilliants. Ugly ducklings though they are, their hardness fits them for work that is vital to the national-defense program.

Tools containing industrial diamonds are of great importance for truing cutting wheels made of the hardest artificial abrasives known, for machining operations on the hard alloy metals that are widely used today, for core drilling in mining and foundation work, and for numerous other purposes. In the form of whole stones or of powder, diamonds are set in circular saws, glaziers' tools, and dies for drawing wire. Anything that will speed up output receives the careful consideration of industry in times such as the present, with the result that manufacturers representing many different lines are investigating the possibilities of diamond-impregnated tools. An exhibit at the World's Fair in New York by English and South African diamond producers was of great benefit to American industrialists in bringing to their attention the comparatively little known potentialities of bort and other varieties of the hardest-known substance.

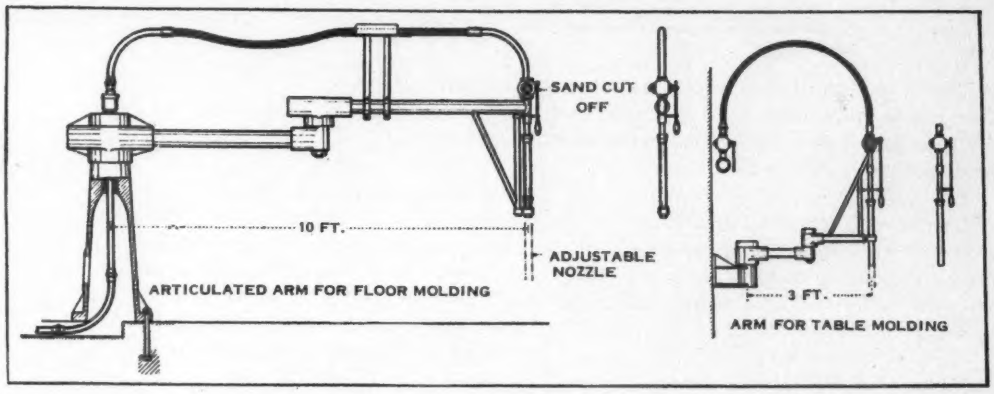
Next in importance to the diamond is corundum, the second-hardest natural stone. It occurs in many forms, the best known of which is perhaps emery. Gem forms are rubies, sapphires, and amethysts, which differ principally in color. All are extensively used for jewels in watches, electric and water meters, and instruments of various types, including some that are vital to the proper control of airplanes. During the first ten months of 1940 more than 80,000,000 of these stones were imported into the United States. Most of them came from Switzerland, and consisted of both the natural and the manufactured article. The greater part of the natural stones originated in Thailand, Ceylon, and India. The synthetic ones—rubies and sapphires—were made in Europe, which is reported to have had a prewar capacity of from 750,000 to 1,000,000 carats a day. All our importations came to us ready for application, for not until recently was a cutting and drilling industry established in this country.

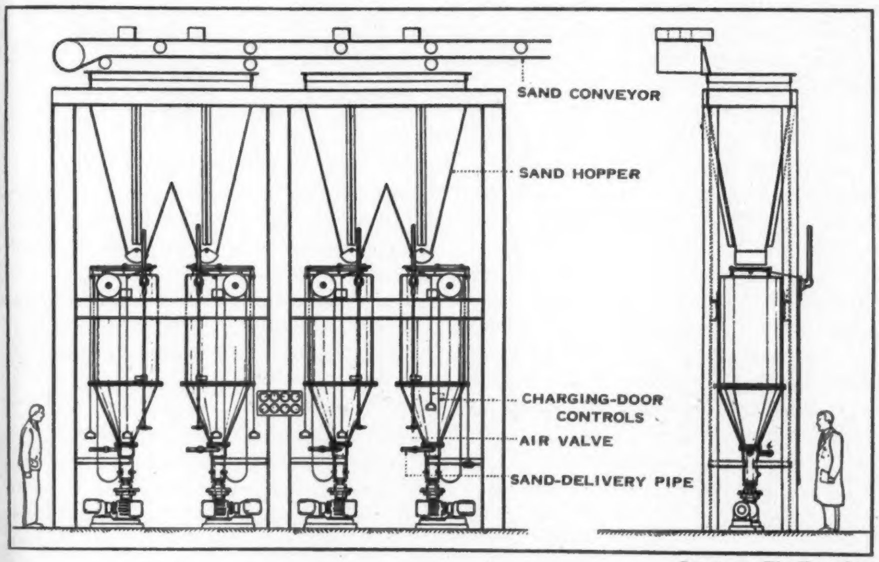
Synthetic-corundum gems are made by melting alumina in an oxyhydrogen flame. The alumina is manufactured from bauxite, but is somewhat purer than that produced in the same way for making aluminum. It is dropped in powder form on the tip of a 4,352°F. flame, and small globules of the molten material fall through the flame to build up a cone-shaped mass called a "boule." When this reaches a weight of approximately ¼ ounce it is cut up into bearings and jewelry stones by means of steel tools and diamond dust. It is said that there is no reason why such stones could not be made in this country, and in all probability steps have already been taken in that direction. Ample supplies of raw material are available from non-European countries and from Montana, which also has stores of the natural stones awaiting mining.

While on the subject of ultrahard stones, it is perhaps fitting to take notice here of the fiftieth anniversary of the Carborundum Company. It was in March, 1891, that the late Dr. Edward G. Acheson succeeded in his quest for an artificial abrasive that would possess some of the properties of the diamond. Working with a small electric furnace, which he had made from an iron bowl, he produced the first manufactured abrasive and compounded a substance that virtually revolutionized industrial grinding work.

Seeking to make a form of crystalline carbon resembling the diamond, he melted a mixture of clay and powdered coke. He was disappointed with the resulting mass, but happened to notice a few bright specks on the end of the arc-light carbon that he had inserted in the mixture. He placed one of the specks on the end of a lead pencil and drew it across a pane of glass, which it readily scratched. Repeating the experiment, he collected enough of the material to test it as an abrasive. Applying some of it to the oiled surface of a disk, he revolved the latter in a lathe and found that he could mark the polished surface of a diamond in a ring that he was wearing. Although he did not know what the crystals were at the time, Doctor Acheson subsequently determined that they were silicon carbide. He gave his product the name of carborundum, and founded the manufacturing concern that is known throughout the industrial world. The first carborundum was sold for 40 cents a carat, or $880 a pound, and was used in the gem trade for the rough polishing of diamonds. It is now made in electric furnaces,, in an extensive modern plant at Niagara Falls, N. Y., by subjecting coke, sand, sawdust, and salt to a temperature of 4,000°F.

Pneumatic Sand-Handling System for Foundries





Courtesy, The Foundry

PAIR OF TWIN GENERATORS

From the preparation plant, the molding sand flows by gravity into the conveyor and thence into the hopper that feeds each generator. Two generally constitute a unit, so that one can be charged while the other is in service. In the generators the sand is aerated and agitated before compressed air forces it out through a pipe to the molding station. There it is directed into the box by an articulated tubular arm (top), the type depending upon whether floor or table molding is being done. So far, the discharge pressure at the nozzle has not exceeded 55 pounds, and a line 60 feet long has been found to be commercially practicable. The system lends itself well to circular or turntable molding stations and is suitable for use with oil- or clay-bonded sand for core-making.

AN IMPROVED system of handling sand for mold-making in foundries operating on a large scale has been developed in Great Britain, where it is being used with interesting results, it is reported. The main feature of the plant is what is termed the generator, in which the sand is aerated and from which it is blown into and through the distribution line with compressed air at from 90 to 100 pounds pressure per square inch, the pressure being reduced by means of a valve in accordance with the nature of the sand and the hardness of mold desired.

The general arrangement of the new system is shown in the accompanying drawings. The sand, as will be seen, is supplied by an overhead conveyor, from which it flows by gravity into a hopper and from there into the generator. The air is introduced just above the base of the inverted cone of the generator in such a way as to filter through the mass, which is further prevented from packing by an agitator driven by an electric motor mounted at the foot of the structure. From the bottom of the generator, the stream of sand and air is conveyed through 1½-inch steel piping to the molding station, 60 feet being the longest practicable distance it has been carried so far.

At the end of the delivery line, and connected to it by a piece of flexible hose, is an electrically operated, articulated tubular arm equipped with an interchangeable and sometimes telescoping nozzle, the type used varying in length and diameter in accordance with the size of the molding box. The arm is guided by the molder, who also controls the flow of sand by means of a valve. It is said that wear and tear on the piping is negligible by reason of the envelope of air in which the sand travels, and that the speed with which the material leaves the nozzle varies little whether the distance is 10 or 60 feet. The resultant molds are of unusual permeability and as hard along the sides of the deepest lifts as they are on horizontal surfaces. Ordinary boxes and patterns are used; and for placing gaggers or other irons, the stream may be stopped temporarily, no signs of cleavage being apparent even when several minutes elapse before the work is resumed. The stripping practices are the same as before, and the equipment is suitable for all types and sizes of molds.

According to *The Foundry*, a small twin-generator plant with a 1-inch outlet delivers from 5 to 7 tons of sand hourly. Each of the two units has a capacity of 3,500 pounds, and while one is being emptied the other is being charged. As an example of the results obtained, let us take a mold of 6½x12x19 inches and a mixture composed of 2½ parts of bentonite, 6 parts of black sand, and 1½ parts coarse silica sand. The box was filled, complete, in half a minute by a man who was not a regular molder; the permeability of the sand in the mold was 120; its moisture content was about 5 per cent; and the castings produced were in every way satisfactory. It is estimated that the new system consumes approximately 225 cubic feet of free air per ton of sand.

Oil From Depleted Wells

DEPLETED wells—wells that have ceased to yield by ordinary methods, are being made to give up the oil remaining underground by a new process developed by members of the staff of the Mineral Fuel Institute of the Academy of Sciences of the Soviet Union. The system, which is referred to as restoring a well, seems to go a step or two further than repressuring, as practiced in the United States. As described in *The Engineer:* Compressed air is heated to 932-1,112°F. and blown down into the oil-bearing formation. Under the pressure of this stream of hot air the oil is easily separated from the reservoir rock and forced a distance of from 300 to 650 feet to the bottom of the well. At the well top production is stimulated by the use of a vacuum pump which sucks up the gas, while a regulation pump serves to bring the oil to the surface. With an experimental installation of small capacity, a depleted area 74 acres in extent yielded in a few months 20,000 tons of oil, more than 353,000,000 cubic feet of gas, and approximately 500 tons of gasoline. At present a 247-acre field in the Maikop District is being thus reworked.

Industrial Notes

The standard diving suit of the U.S. Navy is supplied with helium-oxygen gas for safety and is electrically heated and insulated with Fiberglas for comfort.

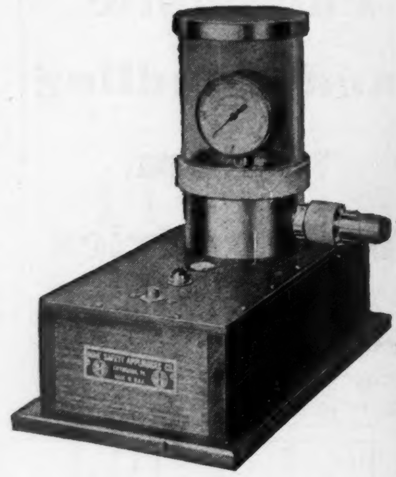
The latest in the way of substitutes introduced abroad are telephone bells of a glass composition instead of metal. They are said to meet all the requirements as to sound and durability.

Phelps Dodge Copper Products Corporation has acquired the United States rights for the manufacture of P-M-G, an alloy of silicon, copper, and iron produced by Vickers-Armstrongs, Ltd. It is claimed that this metal will play an important part in our national defense because it is suitable for many products now made of tin bronzes, thus conserving our tin supply. It is not a substitute for tin.

Handling electric extension cords and lamps in damp and wet places is a dangerous business, as most of us have been taught. To protect men who are exposed to this hazard in their daily work, the Newark Transformer Company has produced a small waterproof transformer element encased in a noncorrosive, nonconducting compound. This unit can be plugged into any 110 or 115 socket and delivers safe 6-volt current to the extension cord attached to the other end.

De-icers on airplane wings—which are expanded and contracted by means of compressed air to break up ice as soon as it forms—have been given increased service life by adding another property to the rubber of which they are made. The fact of the matter is that de-icers sometimes failed because of punctures which permitted the air to escape. These punctures were traced to static; and static is now prevented from doing harm by using rubber having electrical conductivity.

Gauges used in connection with compressed-gas cylinders are subjected to sudden surge pressures in service, and to determine how they will perform under these extreme conditions, Mine Safety Appliances Company has introduced an instrument for testing them. The new Velocity Power Gauge Tester is shown in the accompanying illustration with a gauge in position and covered by a transparent guard that permits observation and protects the operator in case of failure of the gauge. By means of a small blank cartridge, which is inserted in the breech unit of the tester and discharged by a spring-actuated firing pin, pressure is transmitted directly to the gauge mechanism, causing it to function as it would normally under a high initial load. Simultaneously, an electric relay completes a circuit and a signal light indicates that the required test pressure has been applied.



With a metal stylus and Teledeltos—an electrically conductive paper—recording instruments and apparatus can do their work without ink. The paper is discolored when brought in contact with an electric current, which is passed through it by means of the pen. With a sheet traveling an inch a second, and 110-volt direct or alternating current applied through a resistance of from 6,000 to 10,000 ohms, the stylus makes a distinct line or mark. Inkless recording has been practiced for a number of years by the Western Union Telegraph Company, which has recently placed the paper on the market. It is available in rolls from 25 to 30 inches wide and in sheets measuring 25 or 27x23½ inches.

For several years the U.S.S.R. has been using a short-cut method of gasifying coal that reduces to a minimum the cost of production. The conversion takes place in the mine, and the gas is delivered by pipe lines direct to the consumers. Recent laboratory experiments have revealed that it is possible still further to simplify the process by the application of compressed air, thus eliminating some of the preparatory underground work now required. In advance of gasification, it has been the practice to sink shafts and to drive connecting drifts. By the new method, the latter can be dispensed with: only two wells are carried down to the coal seam. When combustion of the fuel *in situ* is underway, compressed air is blown down into one of the shafts and, to quote the London *Engineer*, gas issues from the other. The scheme is to be given a practical test in the Moscow coal basin.

TAPPING HEAT OF STAINLESS STEEL

One of five electric furnaces in the enlarged mill of the Rustless Iron & Steel Corporation at Baltimore, Md., which was put in service last November. This establishment is reported to be the only one in the world devoted exclusively to the making of stainless steel. It has a melting capacity of 75,000 tons a year and employs 1,400 persons. It embodies a straight-line system of production. Ingots are heated at one end of an 1,800-foot-long building and emerge at the other in the form of finished bars and wire. The entire mill has grown up within the past ten years, during which stainless steel has developed from a specialty to a staple steel commodity. The annual consumption in the United States now amounts to more than 2½ pounds per capita.

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